AMERICAN CHEMICAL SERVICE, INC.
GRIFFITH, INDIANA
RESPONSES TO US EPA COMMENTS ON BARRIER WALL EXTRACTION SYSTEM AND ASSOCIATED GROUNDWATER EXTRACTION SYSTEM 50% DESIGN SUBMITTAL AND DISAPPROVAL OF PERFORMANCE STANDARDS VERIFICATION (PSV) PLAN

As requested in US EPA's cover letter dated September 4, 1996, the following are responses to the "essential" comments on the Barrier Wall and Associated Groundwater Extraction System 50 Percent Design Submittal.

General Essential Comments

35. Provide a specific schedule for the performance monitoring program.

    Response: A schedule for the performance monitoring of the BWES is included in Table 9-1 of the Performance Standard Verification Plan (PSVP) and Table 1-1 of the Quality Assurance Project Plan (QAP).

36. Discuss the expected life of the wall based upon the compatibility concerns between the grout and the various chemicals present in the upper aquifer.

    Response: The Polywall is comprised of a 60-mil HDPE geomembrane panel between two 8-inch thick layers of soil-bentonite backfill. "Grout" is not a component of the Polywall. The manufacturer of the HDPE material used for the Polywall reviewed the site contaminants and concluded that they would not significantly degrade the HDPE material. In addition, compatibility testing for the soil-bentonite backfill and the hydrophilic seal in the joints of the Polywall are ongoing to determine the long-term effect that site contaminants will have on these materials. The preliminary results do not indicate any detrimental impacts, but we will notify US EPA of the final results once the tests are complete. Based on the available information, a wall constructed of the HDPE and soil-bentonite backfill is estimated to last 30 years or more.

37. Discuss how Appendix A (Barrier Wall Performance Specifications and Drawings) relates to Section 9 (Performance Standards Verification Plan). It appears to U.S. EPA that Appendix A is part of the PSV Plan; hence, comments regarding Appendix A are included as part of the essential comments.

    Response: The barrier wall performance specification in Appendix A is not part of the Performance Standard Verification Plan. The document is the engineering and construction bid specifications used to procure a subcontractor to construct the barrier wall. The document is referred to as a "performance specification" because it requires the subcontractor to build

the wall to meet certain performance requirements. If we had required the subcontractor to build the wall according to specific construction details, the document would have been referred to as a technical specification. The performance specification does discuss the pump tests to be conducted to assess the integrity of the wall (and thus the subcontractor's performance in constructing the wall), but it was included for the subcontractor's reference. Montgomery Watson will perform the pump test--not the subcontractor--and the details of the testing as described in the final version of the Performance Standard Verification Plan and associated Quality Assurance Project Plan will be followed. Consequently, the details of the testing as described in the performance specification in Appendix A do not need to be updated.

38. Discuss how Appendix F (Quality Assurance Project Plan for Performance Monitoring of the Barrier Wall and Associated Groundwater Extraction System relates to Section 9 (Performance Standards Verification Plan). It appears to U.S. EPA that Appendix F is part of the PSV Plan; hence, comments regarding Appendix F are included as part of the essential comments. Furthermore, as is stated on page 21 of the Unilateral Administrative Order (UAO) Statement of Work (SOW), a Draft Contingency Plan and Draft Field Sampling Plan are required with the Intermediate Design Submittal. Neither document has been included in the 50% design submittal.

    Response: Appendix F (Quality Assurance Project Plan) is for Section 9.0 (PSVP). Comments on the PSVP and QAP are considered essential comments and are responded to accordingly. No field sampling will be performed in conjunction with the BWES construction; therefore, a FSP for the BWES has not been developed. A Contingency Plan for the BWES will be included in the 100 percent design submittal.

39. O&M is critical to proper system performance; hence, inclusion of an O&M plan for the BWES is necessary.

    Response: No O&M is required for the barrier wall. An O&M Plan for the extraction system will be included in the 100 percent design submittal.

<u>Specific Essential Comments</u>

40. **Page 9-1, Section 9.1.** The draft Quality Assurance Project Plan (QAP) which is required to be submitted for performance monitoring of the barrier wall is not included in the document. Include the QAP for EPA review and approval.

    Response: A draft QAP was not included because we needed concurrence on the PSVP before we prepared the QAP. The content of the 50 Percent Design Submittal is consistent with what we described in the Technical Memorandum Dewatering/Barrier Wall Alignment Investigation Report which was submitted to U.S. EPA in April, 1996, and subsequently approved

by U.S. EPA. Nonetheless, we understand U.S. EPA's desire to review a copy of the draft QAP prior to submission of the 100 Percent Design Submittal. To accommodate this request, a draft QAP and revised PSVP are attached with this response to comments on the 50 percent design submittal. The final QAP, which will incorporate U.S. EPA's comments on the draft submittal, will be included with the 100 Percent Design Submittal or, if more review time is needed, it can be issued later as a replacement to the one submitted with the 100 Percent Design Submittal.

41. **Page 9-2, Section 9.2.** Add the following to the performance standards: "Contaminant concentrations will be monitored outside the wall on a regular basis." Propose a specific monitoring program.

    Response: Contaminant concentration monitoring and analytical for the BWES will be conducted as part of the quarterly groundwater monitoring program. The quarterly monitoring program for the ACS Site will be submitted under a separate cover. No specific chemical monitoring program is included with the BWES design submittal. The text in Section 9.2 (bottom of page 9-2) states this.

42. **Page 9-3, Section 9.2.3.** Provide specific operating procedures for the pump test described.

    Response: Standard operating procedures for the pump test are included in Attachment A to the QAP.

43. **Page 9-3, Section 9.2.1., 2nd paragraph.** Explain the response needed to rectify the situation in which an outward gradient is created when pumping for the PGCS lowers the exterior water table below the interior water table.

    Response: There is no response needed to rectify this situation. The discussion of this issue is included in the PSVP so that all parties understand that it may not be possible to achieve an inward gradient along the northern and northwestern boundaries of the barrier wall. If the water table outside the wall is dropped significantly, then lack of an inward gradient along this area does not imply that there is a breach in the wall or that the wall is not performing its intended function. As long as the water table within the wall is lowered, and the quarterly groundwater monitoring data do not indicate migration of contamination from the area within the wall, there will be no reason to believe that the wall is not performing as desired.

44. **Page 9-1, Section 9.2.** Include, as stated in the BWES work plan, a statement that one of the primary objectives for the system is to reduce the amount of groundwater to be pumped into the wetlands.

    Response: Section 9.2 has been modified accordingly.

45. **Page 9-2, Performance Standards Items 1 through 4.** Define a "negligible response." Define which exterior monitoring wells will be used to determine performance. Clarify whether the performance points are piezometers or monitoring wells. Monitoring wells imply that groundwater sampling and analysis will occur. No mention has been made regarding sampling and analysis of monitoring wells which U.S. EPA believes to be a critical component of the performance monitoring. Clarify.

Response: "Negligible response" is defined in Section 9.2.3. Piezometers will serve as performance points; no monitoring wells are to be installed for the BWES. The locations of the piezometers to be used in the performance monitoring of the BWES are shown in Figure 9-1. Chemical monitoring will be conducted as part of the quarterly monitoring program; hence it is not included in the BWES PSVP.

46. **Figure 9-1.** Another piezometer pair is needed along the northern alignment. Page A-1 specifies a spacing of no more than 500 feet between performance monitoring point.

Response: A piezometer pair (P-79/P-80) has been added along the northern alignment of the barrier wall (Figure 9-1).

47. **Appendix A, Page A-1.** Insert date of submittal of the barrier wall performance specification to contractors and explain that this was submitted for bid during preparation of the preliminary design.

Response: The date and explanation has been added to the text. The barrier wall performance specification was sent to the pre-qualified contractors for bidding on April 12, 1996. In order to achieve the proposed construction schedule, preparation of the contractor's bids occurred during preparation of the preliminary design of the barrier wall.

48. **Appendix A, Page A-1, Section 1.1.** Discuss how the design criteria for a hydraulic conductivity of 1×10^{-7} centimeters per second was determined. Explain "extended period of time."

Response: The hydraulic conductivity of 1×10^{-7} cm/sec or less is a soil-bentonite slurry wall industry permeability standard. A 1×10^{-7} cm/sec or less hydraulic conductivity is also the U.S. EPA specified value for low hydraulic conductivity soils in both RCRA Subtitles C and D landfills.

An "extended period of time" relates to language that was used in the barrier wall contract associated with the contractor's bonds.

49. **Appendix A, Section 1.1.** Add the following language to the end of the first sentence: ". . . on a temporary basis."

Response: Comment noted. "on a temporary basis" has been added to the end of the first paragraph.

50. **Appendix A, Section 1.1.** Add the following to the end of the paragraph: "Also, contaminant concentrations will be monitored outside the wall on a regular basis."

Response: The following sentence was added to the end of the paragraph. "Also, contaminant concentrations will be monitored outside the wall on a regular basis." Note that contaminant monitoring will be conducted as part of the quarterly groundwater monitoring program for the ACS Site.

51. **Appendix A, Section 1.2, Second paragraph.** Discuss why it is stated that the wall must be able to meet the objectives for a period of five years beyond construction completion. Discuss whether five years is the intended life of the wall. If so, discuss what happens after the five year period.

Response: The barrier wall must meet the objectives of the performance specification for a period of five years beyond the end of construction. This period was the selected time period that the barrier wall contractor was to warranty the performance of the barrier wall. The warranty period is not the same as the expected life of the wall. If the wall is expected to be in place for 30 years, we would not require the contractor to provide a 30 year warranty. The cost for such an extended warranty would likely be as much as the construction cost. The industry standard is to provide a one year warranty, but we elected to increase that to five years to provide additional protection against the potential for poor workmanship by the contractor. As stated in the response to Comment 36, a wall constructed of HDPE and soil-bentonite backfill is estimated to last 30 years or more. The actual anticipated life of the wall will be decided as part of the design of the final remedy.

52. **Appendix A, Section 1.2, Third paragraph.** Delete the last sentence: ". . . The CONTRACTOR may observe performance monitoring of his choice." It is not appropriate to give the "CONTRACTOR" the option of performance monitoring of his choice. U.S. EPA must approve the performance monitoring program.

Response: The content of the sentence is that the contractor has the option of observing performance monitoring performed by others, not that he has the option of performance monitoring. Performance monitoring is the responsibility of the ACS Technical Committee or their designated consultant, in accordance with U.S. EPA approved methodology.

53. **Appendix A, Page A-1, Section 1.2, 2nd paragraph.** Explain why a performance period of 5 years was chosen.

Response: As discussed in the response to Comment 51, the five year performance period was selected for the period of the barrier wall

contractor's extended warranty. This five year period was selected in order to provide a warranty extending through the majority of the dewatering of the site.

54. **Appendix A, Page A-1, Section 1.2, 3rd paragraph.** Revise the performance specification to represent the proposed plan of installing two piezometers at each performance monitoring point.

    Response: The proposed plan has been changed to reflect two piezometers at each performance monitoring point rather than three piezometers. The revised plan will be included with the 100 percent design submittal.

55. **Appendix A, Page A-2, Section 1.2, Item No. 3.** No previous mention of a tracer test has been stated. State intent and purpose for performing the test. Provide specific operating procedures.

    Response: Reference to a tracer test has been deleted since there is no present intent to use it.

56. **Appendix A, Page A-2, Section 1.2, Item No. 3.** Provide specific operating procedures for the pump test described.

    Response: Specific operating procedures for the pump test are included in the Draft QAP which is attached.

57. **Appendix A, Page A-2, Section 1.2, Item No. 4.** Provide a schedule by which the tests may be repeated. While EPA will agree to leave the option to retest to the ACS technical committee, any new wells must be approved by U.S. EPA. If a failing performance test is not promptly rectified, it may be considered noncompliance.

    Response: Refer to the QAP for actions if a performance monitoring test fails.

58. **Appendix A, Page A-2, Section 1.2, Item No. 5.** Revise the paragraph to delete reference to the CONTRACTOR's cost liability since this information is extraneous to this plan. Discuss a time line for any repairs that are needed, whether within the warranty period or not. Provide a plan for any corrective actions that are necessary.

    Response: The reference to the contractor's cost liability was not deleted, as this performance specification is a contractual relationship between Montgomery Watson and the barrier wall contractor.

    Repairs to the barrier wall within the five year extended warranty period will be made by the contractor, if the ACS Technical Committee purchases the extended warranty. After the five year extended warranty period the

ACS Technical Committee will be responsible for repairs to the barrier wall during the remainder of operation of the groundwater extraction system. Repairs to the barrier wall are expected to occur within six weeks of concluding that repairs are necessary.

59. **Appendix A, Page A-2, Section 1.2, Item No. 6.** Delete the first sentence since monitoring of the barrier wall is not a discretionary activity. Discuss a time line for any repairs that are needed, whether within the warranty period or not. Provide a plan for any corrective actions that are necessary.

Response: The first sentence was left intact since this performance specification is a contractual relationship between Montgomery Watson and the barrier wall contractor.

It is noted that monitoring of the barrier wall will not be a discretionary activity and will be regulated by the U.S. EPA.

A timeline for repairs to the barrier wall was discussed in response to Comment 58. Corrective action measures will be evaluated at the time they are necessary. Options may include excavation and repair of the Polywall, grouting , or some other method.

60. **Appendix A, page A-3, Section 1.2, Item No. 7.** No previous mention regarding testing the hydraulic conductivity of the wall material has been incorporated into the submittal. Clarify in the submittal the intent and purpose of the test. Provide specific operating procedures.

Response: The hydraulic conductivity of the barrier wall material was included in the performance specification for use with soil enhanced barrier wall systems. Since the selected barrier wall technique is a Polywall with a secondary soil-bentonite slurry, the use of hydraulic conductivity of a soil enhanced system does not apply. No specific operating procedures are included.

61. **Appendix F.** The draft Quality Assurance Project Plan (QAP) which shall be submitted for performance monitoring of the barrier wall is not included in the document. Include the QAP in the re-submittal for EPA review and approval.

Response: A draft QAP was not included because we needed concurrence on the PSVP before we prepared the QAP. The content of the 50 Percent Design Submittal is consistent with what we described in the Technical Memorandum Dewatering/Barrier Wall Alignment Investigation Report which was submitted to U.S. EPA in April, 1996, and subsequently approved by U.S. EPA. Nonetheless, we understand U.S. EPA's desire to review a copy of the draft QAP prior to submission of the 100 Percent Design Submittal. To accommodate this request, a draft QAP and revised PSVP are attached with this response to comments on the 50 percent design submittal. The final

QAP, which will incorporate U.S. EPA's comments on the draft submittal, will be included with the 100 Percent Design Submittal or, if more review time is needed, it can be issued later as a replacement to the one submitted with the 100 Percent Design Submittal.

9.0 PERFORMANCE STANDARD VERIFICATION PLAN

9.1 INTRODUCTION

This section presents the Performance Standard Verification Plan (PSVP) that will be used to assess the performance of the BWES to be implemented at the ACS Site. The purpose of the PSVP is to delineate the approach to be used to measure performance of the BWES and to ensure that both short-term and long-term performance standards for this portion of the remedial action are met.

The PSVP for the BWES includes the following plans:

- A Performance Monitoring Program which delineates the field measurements to be conducted to monitor the performance of the BWES. (The monitoring program is described in the following section.)

- A Quality Assurance Project Plan (QAPP) which presents the organization, objectives, functional activities, and specific QA and QC activities associated with the BWES performance monitoring. The QAPP also describes the specific protocols to be followed for water level measurements and other field analyses. The QAPP is included as Appendix F of this document.

- Standard Operating Procedures (SOPs) for pump test, water level measurements, and piezometer installation are included as Attachment A to the QAPP.

- A Health and Safety Plan (HSP) designed to protect on-site personnel and area residents from physical, chemical and other hazards posed while conducting the performance monitoring of the BWES. The HSP is included as Attachment B to the QAPP.

9.2 PERFORMANCE MONITORING PROGRAM

The primary objectives of the BWES are to (1) prevent the migration of contaminants from the waste areas (specifically the Still Bottoms Pond Area and the Off-Site Containment Area) to the site boundary, (2) initiate the dewatering of the waste areas, (3) minimize the recharge of groundwater from surrounding areas while the waste areas are being dewatered, and (4) to reduce the amount of groundwater to be pumped to the wetlands. Two sets of performance standards have been established to confirm that the stated objectives are being met. The first set of standards is quantitative in nature and provides a tool to aid in field measurement of system performance. These performance standards are as follows:

1. An inward gradient across the barrier wall

2. A negligible response (as defined in Section 9.2.3.) in certain exterior piezometers (P-64, P-66, P-68, P-69, P-71, P-73, P-75, P-77, and P-79) during the barrier wall performance pump test

The second set of standards is a qualitative measurement of system performance. These standards will help in establishing a trend to measure the long-term performance of the BWES.

3. An initial decrease in the water level within the barrier wall which will be maintained

4. A decreasing trend in the annual volume of water pumped from the extraction system within the barrier wall

The first and third performance standards will be assessed using water level data from several existing and new piezometers; the second performance standard will be assessed by conducting the specific pump test procedure described in Section 9.2.3.; and the fourth performance standard will be assessed using pump discharge data.

In addition to the above standards, performance of the BWES will be measured based on the contaminant concentrations in the existing monitoring wells outside the barrier wall. In general, the data will be evaluated to confirm that there is no evidence of contaminant migration through or under the wall. The sampling frequency, procedures, and analytical protocols for collecting data from the monitoring wells will be as specified for the quarterly monitoring program to be submitted under a separate cover.

Extracted groundwater from the BWES will be conveyed to the PGCS for treatment and subsequent discharge. Performance standards and the associated monitoring program for the treatment system are included in the PGCS PSVP which was submitted previously.

9.2.1. Water Level Measurements

Water level measurements will be conducted at periodic intervals to verify that an inward gradient exists and to confirm that the water level within the barrier wall has been lowered. Figure 9-1 shows the existing and proposed piezometers that will be used for this purpose. The frequency of water level readings is shown in Table 9-1.

It is important to note that the "inward gradient" performance standard assumes that the water table outside the barrier wall will not drop significantly. This may not be the case along the northern and western portions of the barrier wall while the PGCS extraction trench is operating. The extraction trench may significantly lower the water table outside the wall in these areas and it may initially do so faster than the BWES extraction system lowers the interior water table. If this happens, the inward gradient performance standard will not be considered appropriate for this portion of the barrier wall (i.e., the lack of an inward gradient will not be construed to mean that the barrier wall has failed).

9.2.2. Extraction Pump Discharge Data

The flowrate and volume of water discharged from the groundwater extraction pumps will be used to help confirm that the barrier wall is meeting the objective of minimizing the recharge of groundwater from surrounding areas. If the pump discharge data show that the annual volume of water pumped is decreasing, and the water level data (see Section 9.2.1) demonstrate that the water level within the barrier wall has been lowered, then it can be concluded that the barrier wall is meeting this objective.

A flow meter will be installed on the common discharge line from the extraction pumps to measure the cumulative flow from the entire extraction system. The frequency for collecting the pump discharge data is shown in Table 9-1.

TABLE 9-1

BWES MONITORING PROGRAM

Cumulative Time from Startup*	Monitoring Point	Monitoring Requirement	Frequency
0-7 days	P-20 and P-64 thru P-80	Measure water levels	Once per day
	EW-10 thru EW-18	Measure water levels	Once
	EW-10 thru EW-18 discharge lines and common discharge line	Read totalized and instantaneous flow	Once per day
8-30 days	P-20 and P-64 thru P-80	Measure water levels	Once per week
	EW-10 thru EW-18	Measure water levels	Once per week
	EW-10 thru EW-18 discharge lines and common discharge line	Read totalized and instantaneous flow	Once per week
31-90 days	P-20 and P-64 thru P-80	Measure water levels	Once per month
	EW-10 thru EW-18	Measure water levels	Once per month
	EW-10 thru EW-18 discharge lines and common discharge line	Read totalized and instantaneous flow	Once per month
90 days onward	P-20 and P-64 thru P-80	Measure water levels	Once per quarter
	EW-10 thru EW-18	Measure water levels	Once per quarter
	EW-10 thru EW-18 discharge lines and common discharge line	Read totalized and instantaneous flow	Once per month

* Cumulative time from startup of the extraction system. Startup will occur once the initial equipment/system testing and performance monitoring pump tests are complete.

9.2.3. Barrier Wall Performance Pump Tests

Upon completing construction, the performance of the barrier wall will be assessed by conducting a pump test at each of the eight extraction trenches located around the interior perimeter of the barrier wall. To conduct the pump test, two piezometers will be installed at each extraction sump location: one piezometer will be 20 feet from the sump toward the interior of the Site and the other piezometer will be 10 feet outside the wall (which is 20 feet from the sump) as shown in Figure 9-1.

A 72-hour pump test will then be conducted at each location. The performance of the barrier wall will be evaluated by measuring water levels in the piezometers. If the water level in the outside piezometer drops more than 0.1 feet (adjusted for outside or background influences) while the extraction system is operating, the barrier wall will be deemed as having failed the performance test. Water levels in other piezometers outside the influence of the pump tests will also be monitored to verify that barometric pressure or other factors are not causing water level fluctuations in excess of 0.1 feet. If the water level in the inside piezometer does not drop more than 0.1 feet during the pump test, then the test will be considered unrepresentative. Details of the pump test are included in Attachment A of Appendix F (QAPP).

QUALITY ASSURANCE PROJECT PLAN

BARRIER WALL AND ASSOCIATED GROUNDWATER EXTRACTION SYSTEM

AMERICAN CHEMICAL SERVICE, INC. NPL SITE

GRIFFITH, INDIANA

OCTOBER 1996

PREPARED FOR:

ACS RD/RA EXECUTIVE COMMITTEE

PREPARED BY:

MONTGOMERY WATSON AMERICAS, INC.

QUALITY ASSURANCE PROJECT PLAN

BARRIER WALL AND ASSOCIATED GROUNDWATER EXTRACTION SYSTEM

AMERICAN CHEMICAL SERVICE INC.
NPL SITE
GRIFFITH, INDIANA

OCTOBER 1996

Prepared by: Montgomery Watson

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1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) presents the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities to be used in conducting the performance monitoring of the barrier wall and the associated groundwater extraction system (BWES) at the American Chemical Service, Inc. (ACS) NPL Site. This QAPP also describes the specific protocols which will be followed for field measurements and data collection and reporting specific to the assessment of the performance of the barrier wall. Any sample collection and laboratory analysis to be conducted as part of the BWES performance monitoring will be completed as part of the quarterly monitoring program; therefore, chain-of-custody procedures, sample handling, and the laboratory procedures are not included in this QAPP.

All QA/QC procedures will be in accordance with applicable professional technical standards, U.S. EPA requirements, state regulations, government regulations and guidelines, and specific project goals and requirements. This QAPP was prepared by Montgomery Watson Americas Inc. (Montgomery Watson) in accordance with the following U.S. EPA QAPP guidance documents: the *Contract Laboratory Program (CLP) Guidelines*, *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (QAMS-005/80), and the *Region V Superfund Model QAPP* (May 1996).

1.2 SITE DESCRIPTION

1.2.1. Site Size and Borders

The ACS Site is located at 420 South Colfax Avenue in the City of Griffith, Indiana, which is in the northwestern corner of the state. The Site is bordered on the east and northeast by Colfax Avenue. The Chesapeake and Ohio railway bisects the Site in a northwest-southeast direction, between the fenced On-Site Area (north) and the Off-Site Area (south). On the west and northwest, south of the Chesapeake and Ohio railway, the Site is bordered by the abandoned Erie and Lackawanna railway, and the Griffith Municipal Landfill. North of the Chesapeake and Ohio railway, the Site is bordered on the west by wetland areas. The northern boundary of the Site is formed by the Grand Trunk railway.

The site comprises approximately 30 acres of land and contains five land disposal areas: the On-Site Containment Area (ONCA), the Still Bottoms Pond (SBP) Area, the Treatment Lagoons, the Off-Site Containment Area (OFCA), and the Kapica/Pazmey Area[1]. Although the Griffith Municipal Landfill is located within U.S. EPA's boundaries of the Site, it is not included as part of the remedy. The landfill is an active solid waste disposal facility that has operated since the 1950s and it is currently going through closure.

1.2.2. Operational History

The ACS Site contains an active chemical processing facility and several former land disposal areas. The chemical processing facility began operation in May 1955 as a solvent recovery facility. Solvent recovery remained the primary operation performed on-site through the late 1960s, when the manufacture of small quantities of specialty chemicals began. These manufacturing operations included treating rope with fungicide, bromination and treating ski cable.

In 1961, ACS sold a two-acre parcel to John Kapica, and in 1962 Kapica began the operation of his drum reclaiming business at the location. Operations at Kapica Drum, Inc., consisted of drum reconditioning. Kapica Drum was sold to Pazmey Corporation in February 1980. Kapica/Pazmey operated from 1980 to 1987. The Pazmey Corporation property was sold to Darija Djurovic in March 1987.

ACS' solvent operations involved spent solvent mixtures containing alcohols, ketones, esters, chlorinated solvents, aromatics, aliphatics, and glycols. In the early years of operation, spent solvents were stored in 55-gallon drums at various locations at the Site. Solvent recovery was performed in batch evaporation units, which were charged by pumping material directly from 55-gallon drums into the evaporation vessels. Still

[1] The terms On-Site and Off-Site are used to denote particular portions of the ACS Site: both areas are within the CERCLA Site. The Off-Site Containment area is designated as off-site only because it is adjacent to, rather than within the boundaries of the property where ACS currently conducts its chemical formulation operations. However, ACS owns the property and as noted, for CERCLA purposes, both of these areas are considered on-site.

bottoms from the evaporation vessels were disposed in the Still Bottom Pond, prior to the installation of incinerators at the facility. ACS installed its first incinerator in 1966 and installed a second incinerator in 1969. The incinerators were used to burn still bottoms and non-reclaimable materials generated at the Site, and wastes from off-site. The incinerator units were dismantled in 1977.

From 1970 to 1975, the spent solvents reclaimed at the Site were similar to those which were handled in the 1960s. However, an increasing percentage of shipments were received at the Site in bulk tanker trucks. In addition, the batch manufacturing processes were expanded during this period. A lard oil process which utilized tallow and animal rendering was used to manufacture a lubricant product. This process, along with a soldering flux operation, was discontinued prior to 1990. In 1971, the additive manufacturing area was built. Various detergents lubricants, and chemical additives were manufactured, in addition to soldering flux, various amines, methanol, formaldehyde, sodium hydroxide, and maleic anhydride. An epoxidation plant was constructed in 1974 and a bromination operation using hexane was added in 1975. At various times up until 1990, the epoxidation plant used toluene or benzene as a reaction carrier.

Some time between 1975 and 1990, the solvent distillation units were replaced with new units though the types of solvent wastes reclaimed remained essentially the same. Spent solvent and reclaimed solvent recovery tank farms were constructed during this time period and the majority of the spent solvent waste streams were shipped in bulk tanker trucks, although drummed wastes were still processed. A hazardous waste drum unloading dock and storage area was built in the early 1970s, with spill containment curbing and a sump area added at a later date. In September 1990, ACS ceased accepting hazardous waste shipments and filed for closure. On March 31, 1993, ACS completed closure and terminated its interim RCRA status. ACS currently operates as a chemical production facility at the Site. The operations include chemical reaction processes, custom blending, and product distribution. The facility encompasses 8.5 acres with process building, tank farms, loading and unloading areas, a laboratory, and offices and support utility buildings. The company operates 24 hours per day, five to six days per week. The operating production facility is secured by a continuous fence line with a single, controlled access gate.

1.2.3. Land Disposal History

When ACS began operations in 1955, the still bottoms from the solvent recovery operations were disposed of in the Still Bottoms Pond/Treatment Lagoon area. In 1972, the pond and lagoons were drained, and drums, partially filled with sludge materials, were landfilled there.

The OFCA was utilized for the landfilling of wastes including excavated materials from the Still Bottoms/Treatment Lagoon from 1958 to 1975. The waste types disposed of in the OFCA over the course of ACS' operations also included general refuse, drums, still bottoms and incinerator ash. According to the ACS, Inc. owner/operator, drums placed in the OFCA were crushed or punctured as part of the disposal process.

During the mid-1960s, it is estimated that approximately 400 drums of sludge and semi-solids were landfilled in the ONCA. Observations made during test pit excavations in 1993 did not detect any intact drums. Residual wastes and rinse waters from the Kapica/Pazmey drum reconditioning operation were disposed of on the ground in the Kapica/Pazmey Area.

1.2.4. Administrative History

In February 1980, the U.S. EPA performed a Preliminary Assessment of the ACS Site, collecting samples in the Off-Site Containment Area and at the Griffith Municipal Landfill in May 1980. The U.S. EPA performed a site inspection on September 9, 1980, and in July 1982, U.S. EPA contractors installed four monitoring wells near the Off-Site Containment Area and the Griffith Landfill. Based upon information developed during these investigative efforts, a hazard ranking system score of 34.98 was assigned to the ACS Site by U.S. EPA in June 1983.

In 1986, a group of approximately 125 Potentially Responsible Parties (PRPs) formed a Steering Committee to conduct the Remedial Investigation/Feasibility Study (RI/FS) pursuant to an agreement with the U.S. EPA. The PRPs signed a Consent Order to perform the RI/FS in June 1988. Following U.S. EPA approval of the RI/FS Work Plan, the field investigation for Phase I of the RI began in July 1989. Phase II RI field work began in March 1990, and in December 1990, the Phase III RI field work was initiated.

The RI report was completed in June 1991. Warzyn (now Montgomery Watson Americas, Inc.) completed the FS report in June 1992.

In June 1992, the U.S. EPA published notice of its Proposed Plan for Remedial Action for the ACS Site. The remedy presented in that Proposed Plan was described by U.S. EPA as a modification of Remedial FS Alternative 6B. The U.S. EPA issued a Record of Decision (ROD) in September 1992. The UAO was issued on September 30, 1994. The Respondents provided notice to the U.S. EPA of their intent to comply with the UAO, and have developed the planning documents and performed other tasks required by the UAO to date.

1.3 PAST DATA COLLECTION ACTIVITIES

For information pertaining to past data collection activities at the Site, refer to the RI report described above.

1.4 CURRENT STATUS

The Site is currently in the Remedial Design/Remedial Action (RD/RA) stage, with some components of the remedy such as the perimeter groundwater containment system and the barrier wall and associated groundwater extraction system currently under construction.

1.5 PROJECT OBJECTIVES AND SCOPE

This QAPP addresses the performance monitoring activities for the BWES. Tasks addressed by this QAPP are water level monitoring, flow rate monitoring, and pump tests. The overall objective of the project and objectives for the water level monitoring, flow rate monitoring, and pump tests are described below.

The objectives of the barrier wall and associated extraction system are to (1) prevent the migration of contaminants from the waste areas (specifically the Still Bottoms Pond/Treatment Lagoon Area and the Off-Site Containment Area) to the site boundary, (2) initiate the dewatering of the waste areas, (3) minimize the recharge of groundwater from surrounding areas while the waste areas are being dewatered, and (4) reduce the amount of groundwater to be pumped to the wetlands. Two sets of performance standards have been established to confirm that the stated objectives are being met.

The first set of standards is quantitative in nature and provides a tool to aid in field measurement of system performance. These performance standards are as follows:

1. An inward gradient across the barrier wall

2. A negligible response (as defined in Section 1.5.3.) in certain exterior piezometers during the barrier wall performance pump test

The second set of standards is a qualitative measurement of system performance. These standards will help in establishing a trend to measure the long-term performance of the BWES.

3. An initial decrease in the water level within the barrier wall which will be maintained

4. A decreasing trend in the annual volume of water pumped from the extraction system within the barrier wall

The first and third performance standards will be assessed using water level data from several existing and new piezometers; the second performance standard will be assessed by conducting the specific pump test procedure described in Section 1.5.3.; and the fourth performance standard will be assessed using pump discharge data.

In addition to the above standards, performance of the BWES will be measured based on the concentrations of contaminants in the existing monitoring wells outside the barrier wall. In general, the data will be evaluated to confirm that there is no evidence of contaminant migration through or under the wall. The sampling frequency, sampling procedures, and analytical protocols for collecting data from the monitoring wells will be as specified for the quarterly monitoring program to be submitted under a separate cover.

Extracted groundwater from the BWES will be conveyed to the PGCS for treatment and subsequent discharge. Performance standards and the associated monitoring program for the treatment system are included in the PGCS PSVP which was submitted previously.

1.5.1. Water Level Measurements

Water level measurements will be conducted at periodic intervals to verify that an inward gradient exists and to confirm that the water level within the barrier wall has been lowered. Figure 1-1 shows the existing and proposed piezometers that will be used for this purpose.

It is important to note that the "inward gradient" performance standard assumes that the water table outside the barrier wall will not drop significantly. This may not be the case along the northern and western portions of the barrier wall while the PGCS extraction trench is operating. The extraction trench may significantly lower the water table outside the wall in these areas and it may initially do so faster than the BWES extraction system lowers the interior water table. If this happens, the inward gradient performance standard will not be considered appropriate for this portion of the barrier wall..

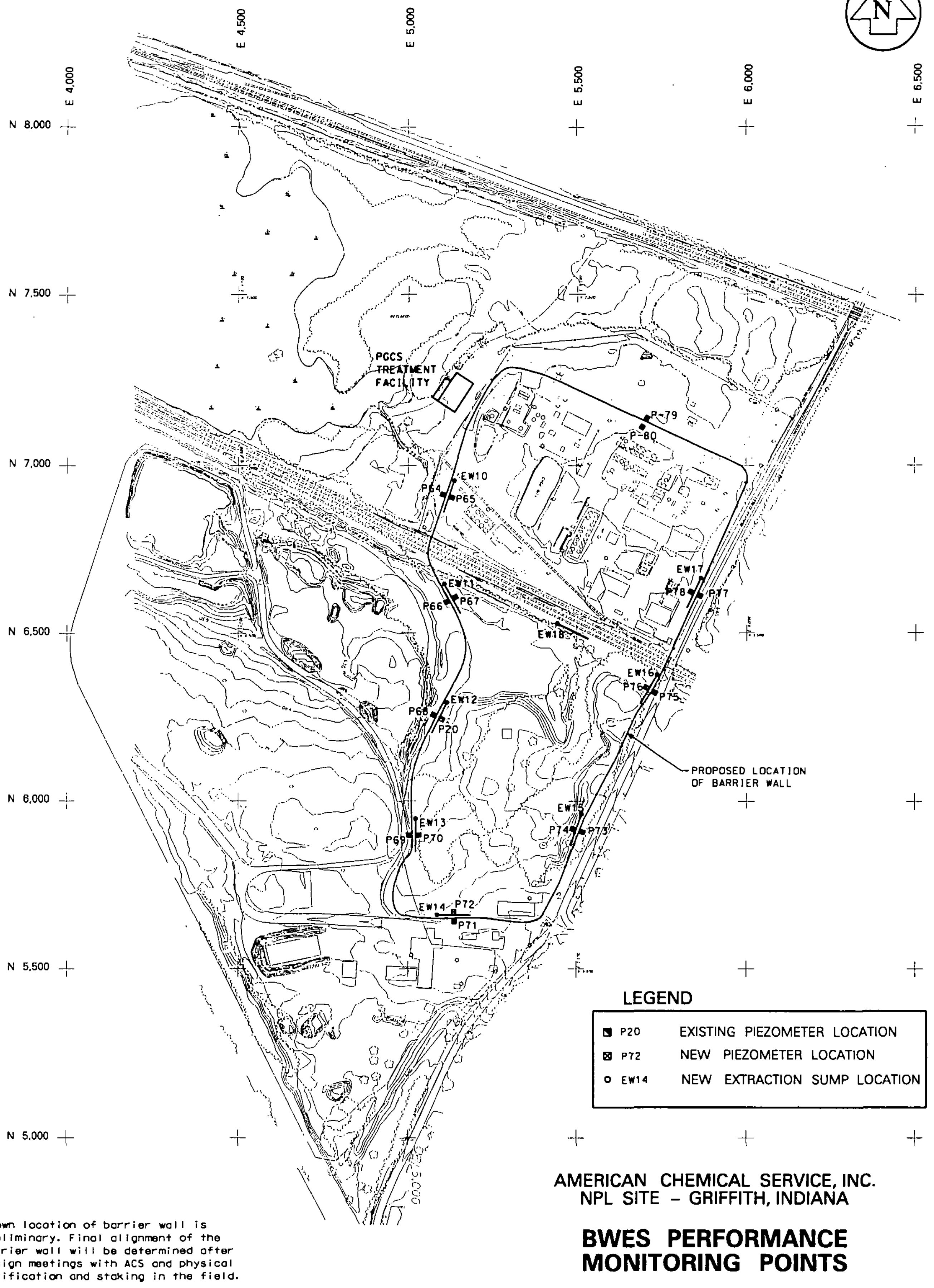
1.5.2. Extraction Pump Discharge Data

The flowrate and volume of water discharged from the groundwater extraction pumps will be used to help confirm that the barrier wall is meeting the objective of minimizing the recharge of groundwater from surrounding areas. If the pump discharge data show that the annual volume of water pumped is decreasing, and the water level data (see Section 1.5.1.) demonstrate that the water level within the barrier wall has been lowered, then it can be concluded that the barrier wall is meeting this objective.

A flow meter will be installed on the common discharge line from the extraction pumps to measure the combined cumulative flow from the entire extraction system.

1.5.3. Barrier Wall Performance Pump Tests

Upon completing construction, the performance of the barrier wall will be assessed by conducting a pump test at each of the eight extraction trenches located around the



LEGEND

■	P20	EXISTING PIEZOMETER LOCATION
⊠	P72	NEW PIEZOMETER LOCATION
o	EW14	NEW EXTRACTION SUMP LOCATION

Shown location of barrier wall is preliminary. Final alignment of the barrier wall will be determined after design meetings with ACS and physical verification and staking in the field.

AMERICAN CHEMICAL SERVICE, INC.
NPL SITE – GRIFFITH, INDIANA

BWES PERFORMANCE MONITORING POINTS

FIGURE 1–1

JOB No. 4077.0183 File fig_1-1.dgn (10/26/96) perimeter of the barrier wall. To conduct the pump test, two piezometers will be installed at each extraction sump location: one piezometer will be 20 feet from the sump toward the interior of the Site and the other piezometer will be 10 feet outside the wall (which is also 20 feet from the sump) as shown in Figure 1-1.

A 72-hour pump test will then be conducted at each location. The performance of the barrier wall will be evaluated by measuring water levels in the piezometers. If the water level in the outside piezometer drops more than 0.1 feet (adjusted for background or outside influences) while the extraction system is operating, the barrier wall will be deemed as having failed the performance test. Water levels in other piezometers outside the influence of the pump tests will also be monitored to verify that barometric pressure or other factors are not causing water level fluctuations in excess of 0.1 feet. If the water level in the inside piezometer does not drop more than 0.1 feet during the pump test, then the test will be considered unrepresentative. Details of the pump test are included in Attachment A.

1.5.4. Project Target Parameters and Intended Data Uses

Parameters to be monitored as a part of this project are groundwater elevation and extraction system flow rate. The intended data use is to evaluate the performance of the barrier wall by measuring the groundwater elevation and the flowrate and volume of water discharged from the groundwater extraction pumps. All of these are field measurements and require no sample collection for analyses. Analytical samples to be collected for evaluating/monitoring of the treatment system for extracted groundwater is not a part of this task and has been addressed in a separate QAPP for the PGCS treatment system.

1.5.5. Quality Objectives and Criteria for Measurement Data

The Data Quality Objective (DQO) Process is a series of planning steps based on the Scientific Method that is designed to ensure that the type, quality, and quantity of environmental data used in decision making are appropriate for intended application. DQOs are qualitative and quantitative statements derived from outputs of each step of the DQO Process that (1) clarify the study objective, (2) define the most appropriate type of data to collect, and (3) determine the most appropriate conditions from which to collect the data. The DQO Process allows decision makers to define their data requirements and acceptable levels of decision during planning before any data are collected. The project specific DQO process is as follows:

1. **STATE THE PROBLEM.** Summarize the problem that will require new environmental data, and identify the resources available to resolve the problem.

   - The problem is to evaluate the performance of the barrier wall and extraction system.

2. **IDENTIFY THE DECISION**. Identify the decision to be made.

   - Determine whether the barrier wall and extraction system will provide a continuous barrier to groundwater migration, or if groundwater will migrate through the wall.

3. **IDENTIFY INPUTS TO THE DECISION**. Identify the information needed to support the decision, and specify which inputs require new environmental measurements.

   - Required information includes water level measurements on both sides of the barrier wall, to be collected prior to, during, and after the pumping test, and extraction system flowrate and volume of groundwater extracted.

4. **DEFINE THE STUDY BOUNDARIES.** Specify the spatial and temporal aspects of the environmental media that the data must represent to support the decision.

   - Study spatial boundaries are defined by the barrier wall.

5. **DEVELOP A DECISION RULE**. Develop a logical "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative actions.

- A 72-hour pump test will be conducted at each of the perimeter extraction trenches. The performance of the barrier wall will be evaluated by measuring water levels in the piezometers. If the water level in the outside piezometer drops more than 0.1 feet while the extraction system is operating, then the barrier wall will be deemed as having failed the performance test.

- Water level measurements will be taken at each of the piezometers shown in Figure 1-1. If the water level in the outside piezometer of each pair is higher than the water level in the inside piezometer, an inward gradient exists.

- Flowrate and total volume of groundwater pumped from the extraction system will be monitored. If pump discharge data show that the annual volume of water pumped is decreasing, and the water level data demonstrate that the water level within the barrier wall has been lowered, then it can be concluded that the barrier wall is minimizing the recharge of groundwater from surrounding areas.

6. **SPECIFY LIMITS ON DECISION ERRORS**. Specify decision maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data.

   - If the water level in the inside piezometer does not drop more than 0.1 feet, then the test will be considered unrepresentative.

7. **OPTIMIZE THE DESIGN FOR OBTAINING THE DATA**. Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs.

   - Perform 72-hour pump tests at each location after construction and evaluate the resulting data.

1.6 MONITORING NETWORK DESIGN AND RATIONALE

Groundwater elevations in piezometers inside and outside the barrier wall, and extraction system flow will be measured to monitor performance of the barrier wall and the extraction system. Table 1-1 shows the locations and monitoring frequency. In addition, a 72-hour pump test will be conducted at each of the eight extraction trenches located around the barrier wall perimeter. Pump test procedures are provided in Attachment A.

Refer to Table 1-2 for a summary of data generating activities and associated quality objectives.

1.7 PROJECT SCHEDULE

The 72-hour pumping tests will be performed following construction of the barrier wall, and prior to start-up of the groundwater extraction system. The current schedule is for this activity to occur in late February or early March of 1997. The ongoing performance monitoring activities such as water level monitoring, and groundwater flowrate and extraction volume monitoring will begin with the startup of the extraction system. Startup will occur after all of the pump tests have been completed.

TABLE 1-1

BWES MONITORING PROGRAM

Cumulative Time from Startup*	Monitoring Point	Monitoring Requirement	Frequency
0-7 days	P-20 and P-64 thru P-80	Measure water levels	Once per day
	EW-10 thru EW-18	Measure water levels	Once
	EW-10 thru EW-18 discharge lines and common discharge line	Read totalized and instantaneous flow	Once per day
8-30 days	P-20 and P-64 thru P-80	Measure water levels	Once per week
	EW-10 thru EW-18	Measure water levels	Once per week
	EW-10 thru EW-18 discharge lines and common discharge line	Read totalized and instantaneous flow	Once per week
31-90 days	P-20 and P-64 thru P-80	Measure water levels	Once per month
	EW-10 thru EW-18	Measure water levels	Once per month
	EW-10 thru EW-18 discharge lines and common discharge line	Read totalized and instantaneous flow	Once per month
90 days onward	P-20 and P-64 thru P-80	Measure water levels	Once per quarter
	EW-10 thru EW-18	Measure water levels	Once per quarter
	EW-10 thru EW-18 discharge lines and common discharge line	Read totalized and instantaneous flow	Once per month

* Cumulative time from startup of the extraction system. Startup will occur once the initial equipment/system testing and performance monitoring pump tests are complete.

TABLE 1-2

INTENDED DATA USAGE

Activity	Description	Parameters	Intended Data Usage
Pumping Test	Pump groundwater from extraction trenches while monitoring groundwater elevations inside and outside the barrier wall.	Water levels	Assess performance of the barrier wall for containing contaminated water.
Water level Monitoring	Measure water levels in piezometers during extended operation of extraction system and barrier wall	Water levels	Assess continuing performance of barrier wall and extraction system for containing contaminated water.
Extraction Flow Rate	Measure flow rate and total quantity of groundwater extracted from extraction system	Flow rate	Assess performance of extraction system for removing groundwater, and monitor quantity of water extracted.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

At the direction of the ACS RD/RA (ACS PRP) Executive Committee and the approval of the U.S. EPA, Montgomery Watson has overall responsibility for the performance monitoring of the barrier wall and the associated groundwater extraction system at the ACS Site. The various quality assurance and management responsibilities of key project personnel are defined below. A site specific project organization chart is provided as Figure 2-1. Because no laboratory tests are included as part of this QAPP, no laboratory or data validation is required.

2.1 OVERALL RESPONSIBILITY

2.1.1. U.S. EPA Region V Project Manager

The U.S. EPA Region V is the lead agency and is responsible for providing oversight of the ACS remedial design. The U.S. EPA Project Manager has the responsibility for review and approval of this QAPP. The U.S. EPA Project Manager is Ms. Sheri Bianchin. RPM responsibilities encompass acting as the coordinator of communications among the U.S. EPA, Indiana Department of Environmental Management (IDEM), the ACS PRPs, and Montgomery Watson.

2.1.2. IDEM Project Manager

The IDEM Project Manager is Ms. Holly Grejda. Ms. Grejda is responsible for ensuring that the State of Indiana's environmental requirements are met.

2.1.3. ACS PRPs

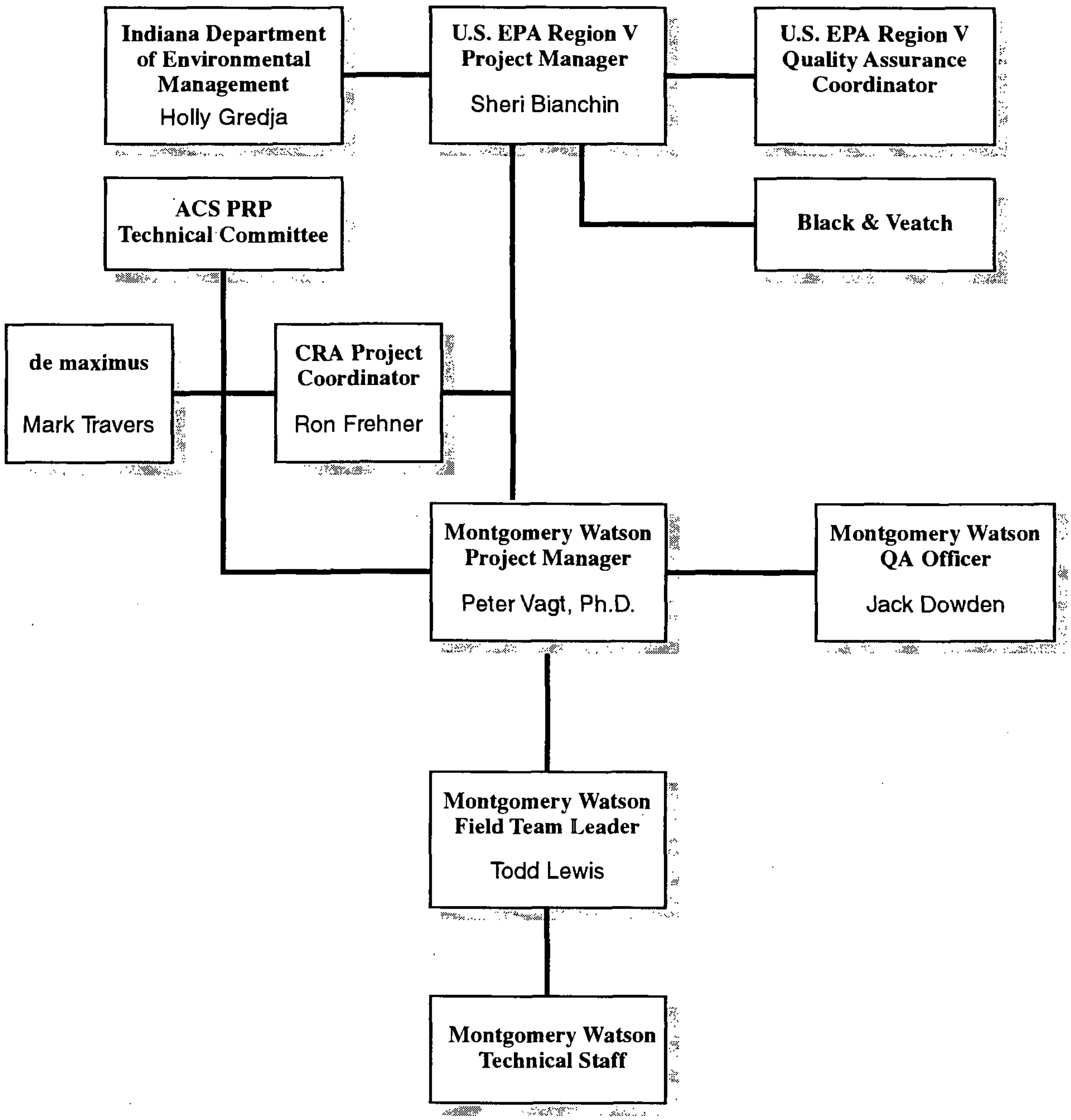
The ACS PRPs are responsible for implementing the project, and have the authority to obtain resources necessary to meet the project objectives and requirements. The ACS PRPs are represented by Mr. Ron Frehner and Mr. Mark Travers. Mr. Frehner's primary function is to ensure that the project technical and scheduling objectives are successfully achieved. Mr. Travers' primary function is to provide technical input and to manage the financial aspects of the project.

QUALITY CONTROL

Graphic Standards ___ Lead Professional ___

Technical Review ___ Project Manager ___

Management Review ___ Other ___



This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

FIGURE 2-1

Developed By *RJS*	Drawn By *DJB*	**PROJECT ORGANIZATION CHART**	Drawing Number 4077.0184
Approved By	Date *8/17/96*	BWES PERFORMANCE MONITORING AMERICAN CHEMICAL SERVICE, INC. NPL SITE GRIFFITH, INDIANA	**MONTGOMERY WATSON**
Reference			
Revisions *0*			

2.1.4. Montgomery Watson Project Manager

Montgomery Watson is the contractor for the ACS PRPs and is responsible for implementing the BWES and the performance monitoring system. The Montgomery Watson Project Manager is Dr. Peter Vagt. Dr. Vagt has the overall responsibility for ensuring that the U.S. EPA project objectives and Montgomery Watson's quality standards are met. In addition, he is responsible for technical quality control and project oversight, and provides the ACS PRPs with access to corporate management. Dr. Vagt's responsibilities include:

- Defining project objectives and developing a detailed schedule
- Establishing project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task
- Acquiring and applying technical and corporate resources as needed to ensure performance within budget and schedule constraints
- Orienting all field leaders and support staff concerning the project's special considerations
- Monitoring and directing the field leaders
- Developing and meeting ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product
- Reviewing the work performed on each task to ensure its quality, responsiveness, and timeliness
- Reviewing and analyzing overall task performance with respect to planned requirements and authorizations
- Approving all external reports (deliverables) before their submission to the U.S. EPA

- Preparing and ensuring the quality of design and construction submittals
- Representing the project team at meetings and public hearings.

2.1.5. Montgomery Watson Field Team Leader

The Montgomery Watson field team leader is Todd Lewis. Mr. Lewis is responsible for leading and coordinating the day-to-day activities of the various resource specialists under his supervision. The Montgomery Watson field team leader reports directly to the Montgomery Watson Project Manager. Specific field team leader responsibilities include:

- Providing day-to-day coordination with the project manager on technical issues in specific areas of expertise
- Developing and implementing field-related work plans, assurance of schedule compliance, and adherence to management developed study requirements
- Coordinating and managing field staff
- Implementing QC for technical data provided by the field staff including field measurement data
- Adhering to work schedules provided by the project manager
- Generating, reviewing, and approving text and graphics required for field team efforts
- Coordinating and overseeing technical efforts of subcontractors assisting the field team

- Identifying problems at the field team level, discussing resolutions with the project manager, and providing communication between team and upper management

- Participating in the preparation of project reports.

2.1.6. Montgomery Watson Quality Assurance Officer

The Montgomery Watson Quality Assurance Officer (QAO) is Mr. Jack Dowden. The QAO will remain independent of direct job involvement and day-to-day operations, and has direct access to corporate executive staff as necessary to resolve any QA dispute. The QAO is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations, Montgomery Watson's policies, and state requirements. Specific functions and duties include:

- Providing QA audit on various phases of the field operations
- Reviewing and approving QA plans and procedures
- Providing QA technical assistance to project staff.

2.1.7. U.S. EPA Region V Quality Assurance Coordinator

The U.S. EPA Region V Quality Assurance Coordinator has the responsibility to review and approve all Quality Assurance Project Plans.

2.1.8. Technical Staff

The technical staff for this project will be drawn from Montgomery Watson's pool of corporate resources. The technical staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical staff are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

2.2 SPECIALIZED RESPONSIBILITIES

2.2.1. Monitoring and Sampling Operations and QC

- Field Measurements - Montgomery Watson, Addison, Illinois

- On-site Day to Day Field Activities - Field Team Leader, Montgomery Watson, Addison, Illinois

- Quality Control - QAO, Montgomery Watson, Addison, Illinois

2.2.2. Performance and Systems Audits

2.2.2.1. Field Operations

- Internal Audits - QAO, Montgomery Watson, Addison, Illinois
- External Audits - to be conducted at the discretion of the U.S. EPA.

2.2.2.2. Final Evidence File

- Final Evidence File Audits - QAO, Montgomery Watson, Addison, Illinois

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this project is to develop and implement procedures for field measurements and reporting that will provide results which are legally defensible in a court of law. Specific procedures for field measurements, reporting of data, internal quality control, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this QAPP.

3.1 PRECISION

3.1.1. Definition

Precision is a measure of the degree to which two or more measurements are in agreement.

3.1.2. Field Precision Objectives

Field precision is assessed by taking duplicate measurements.

3.1.3. Laboratory Precision Objectives

No laboratory procedures are included in this QAPP.

3.2 ACCURACY

3.2.1. Definition

Accuracy is the degree of agreement between an observed value and an accepted reference value.

3.2.2. Field Accuracy Objectives

Accuracy in the field is assessed through the adherence to all field measurement SOPs.

3.2.3. Laboratory Accuracy Objectives

No laboratory procedures are included in this QAPP.

3.3 COMPLETENESS

3.3.1. Definition

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

3.3.2. Field Completeness Objectives

Field completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. The equation for completeness is presented in Section 12.0 of this QAPP. Field completeness for this project will be greater than 90 percent.

3.3.3. Laboratory Completeness Objectives

No laboratory procedures are included in this QAPP.

3.4 REPRESENTATIVENESS

3.4.1. Definition

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

3.4.2. Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the field sampling plan is followed and that proper sampling techniques are used.

3.4.3. Measures to Ensure Representativeness of Laboratory Data

No laboratory procedures are included in this QAPP.

3.5 COMPARABILITY

3.5.1. Definition

Comparability is an expression of the confidence with which one data set can be compared with another. Comparability is also dependent on similar QA objectives.

3.5.2. Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the specific field measurement SOPs are followed.

3.5.3. Measures to Ensure Comparability of Laboratory Data

No laboratory procedures are included in this QAPP.

3.6 LEVEL OF QUALITY CONTROL EFFORT

The QC level of effort for the field measurements of flow rates consists of pre-measurement calibration and a post-measurement verification according to the manufacturers instruction manual. This procedure will be performed for each pumping test.

4.0 FIELD MEASUREMENT PROCEDURES

Field measurement procedures are described in the SOPs, which are contained in Attachment A of this document.

5.0 SAMPLE CUSTODY

Custody is one of several factors which is necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area. Because no laboratory samples are included in this task, these section have been omitted from this QAPP.

A sample or evidence file is under your custody if:

- the item is in actual possession of a person; or
- the item is in the view of the person after being in actual possession of the person; or
- the item was in actual physical possession but is locked up to prevent tampering; or
- the item is in a designated and identified secure area.

5.1 FIELD LOGBOOKS/DOCUMENTATION

Field logbooks will provide the means of recording data collecting activities performed. As such, entries will be described in as much detail as possible so that persons going to the Site could re-construct a particular situation without reliance on memory.

Field logbooks will be bound, field survey books or notebooks. Logbooks will be assigned to field personnel, but will stored in the final evidence file described in Section 5.2 when not in use. Each logbook will be identified by the project-specific document number.

The title page of each logbook will contain the following:

- Person to whom the logbook is assigned
- Logbook number
- Project name
- Project start date
- Project end date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the Site, field sampling or investigation team personnel, and the purpose of their visit will also be recorded in the field logbook.

Measurements made will be recorded. All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark and initialed and dated by that person. Whenever a measurement is made, a detailed description of the location of the station, which includes compass and distance measurements, shall be recorded. The number of the photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

5.2 FINAL EVIDENCE FILES CUSTODY PROCEDURES

The final evidence files for investigation data are maintained by Montgomery Watson at the office from which the project is being managed, as specified in Section 2.2.4. of this document. The content of the evidence file will include all relevant records, reports, correspondence, logs, field logbooks, data package, pictures, subcontractor's reports, chain of custody records/forms, and data review reports. The evidence file will be under custody of the Montgomery Watson project manger in a locked, secured area.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

This section describes the calibration procedures and the frequency at which these procedures will be performed for both field and laboratory instruments.

6.1 FIELD INSTRUMENT CALIBRATION

The field instruments will be calibrated as described in field SOPs. Field instruments include a flow meter and electric water level. As a rule, instruments will be calibrated daily prior to use and will be recalibrated after each pumping test. For specific instructions on the calibration frequency, the acceptance criteria and the conditions that will require more frequent recalibration, refer to the specific SOPs for each field analysis.

The linearity of the flow meter will be checked as detailed in the manufacturers operating instructions. All the calibration procedures performed will be documented in the field logbook and will include the date/time of calibration, name of person performing the calibration, reference standard used, temperature at which readings were taken and the readings. Multiple readings on one samples will likewise be documented.

6.2 LABORATORY INSTRUMENT CALIBRATION

No laboratory procedures are included in this QAPP.

7.0 ANALYTICAL PROCEDURES

No sample collection or analytical procedures will be performed in conjunction with the barrier wall performance monitoring or the groundwater extraction system.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 FIELD MEASUREMENT

QC procedures for flow rate measurements are limited to checking the reproducibility of the measurement by obtaining multiple readings and by calibrating the instruments.

QC procedures for water level measurements is limited to setting the pressure transducer reference setting to 0.0 after the transducer has been placed and the water level has stabilized.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

9.1 DATA REDUCTION

9.1.1. Field Measurements

Raw data from field measurements (flow rate and water level) will be appropriately recorded in the field log book. Data logger files will be downloaded as required. Data will be reviewed to ensure procedures were followed and QC requirements were met, however no formal data validation effort will be performed. If the data are to be used in the project reports, they will be reduced onto data summary tables and the method of reduction will be documented.

9.2 DATA VALIDATION

9.2.1. Field Measurements

Data will be reviewed to ensure procedures were followed and QC requirements were met, however, no formal data validation effort will be performed.

9.3 DATA REPORTING

Field data generated for the Site will be presented in a format organized to facilitate data review and evaluation. A narrative including a description of any deviations from the procedures, explanation of qualifications regarding data quality, and any significant problems encountered during field measurements will be included.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of the field activities will be conducted to verify that the measurements are performed in accordance with the procedures established in the FSP and QAPP. The audits of field activities include two separate independent parts: internal and external audits.

10.1 FIELD AUDITS

10.1.1. Internal Audits

Internal audits of field measurements will be conducted by the Montgomery Watson QAO and/or Field Team Leader. The audits will include examination of field sampling records, field instrument operating records, and maintenance of QA procedures. These audits will occur at the onset of the project to verify that all established procedures are followed. Follow-up audits will be conducted to correct deficiencies, and to verify that QA procedures are maintained throughout the project duration. The audits will involve review of field measurement records, and instrumentation calibration records.

10.1.2. External Audits

External audits will be conducted at the discretion of the U.S. EPA and the IDEM.

11.0 PREVENTATIVE MAINTENANCE PROCEDURES

11.1 FIELD EQUIPMENT/INSTRUMENTS

The field equipment for this project includes flow meters and water level indicators. Specific preventive maintenance procedures to be followed for field equipment are those recommended by the manufacturer.

Field instruments will be checked and calibrated before they are shipped or carried to the field. These instruments will be checked and calibrated daily before use. Calibration checks will be performed after every 10 samples and will be documented in the field log books.

Backup instruments and equipment should be available on-site or within one-day shipment to avoid delays in the field schedule.

Maintenance is carried out on a regular, scheduled basis, and is documented in the instrument service logbook. Emergency repair or scheduled manufacturer's maintenance is provided by the on-site technician or maintenance contract with the factory representative.

12.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 FIELD MEASUREMENTS

Field data will be assessed by the Montgomery Watson Field Team Leader. The Field Team Leader will review the field results for compliance with the established QC criteria that are specified in the QAPP and FSP.

12.1.1. Accuracy Assessment

Accuracy is generally assessed by analyzing spike samples. Because no laboratory analyses are planned, this procedure cannot be utilized. Accuracy of the field measurements will be assessed using daily instrument calibration.

12.1.2. Precision Assessment

Precision is usually determined by splitting a sample and analyzing duplicate aliquots. The splitting of the sample allows the analyst to determine the precision of the preparation and analytical techniques associated with the duplicate sample. The relative percent difference (RPD) between the spike and duplicate spike will be calculated and plotted. The RPD is calculated according to the following formula:

$$\text{RPD} = \frac{\text{Amount in Spike 1} - \text{Amount in Spike 2}}{0.5(\text{Amount in Spike 1} + \text{Amount in Spike 2})} \times 100$$

Because no laboratory analysis is planned, assessment of precision is limited to comparison of duplicate field measurements. Precision will be assessed on the basis of reproducibility by multiple readings.

12.1.3. Completeness Assessment

Completeness is the ratio of the number of valid sample results to the total number of tests. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{\text{(number of valid measurements)}}{\text{(number of measurements planned)}} \times 100$$

13.0 CORRECTIVE ACTIONS

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or out of quality control performance which can affect data quality. Corrective action can occur during field activities and data assessment. All corrective action proposed and implemented will be documented in the regular quality assurance reports to management. Corrective action should only be implemented after approval by the project manager, or his designee, the field operations manager. If immediate corrective action is required, approvals secured by telephone from the project manager should be documented in an additional memorandum.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem will be responsible for notifying the project manager, who in turn will notify the U.S. EPA Remedial Project Manager. Implementation of corrective action will be confirmed in writing through the same channels.

Any nonconformance with the established quality control procedures in the QAPP will be identified and corrected in accordance with the QAPP. The U.S EPA Remedial Project Manager (RPM), or his designee, will issue a nonconformance report for each nonconformance condition.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by stop-work order by the RPM.

13.1 FIELD CORRECTIVE ACTION

Corrective action in the field can be needed when the sample network is changed (i. e. more/less samples, sampling locations other than those specified in the QAPP, etc.), sampling procedures and/or field analytical procedures require modification, etc. due to unexpected conditions. Technical staff and project personnel will be responsible for reporting all suspected technical or QA nonconformances or suspected deficiencies of any activity or issued document by reporting the situation to the Field Team Leader or designee. The Field Team Leader will be responsible for assessing the suspected problems in consultation with the Project QA Manager on making a decision based on the potential for the situation to impact the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the manager.

The Field Team Leader will be responsible for ensuring that corrective action for nonconformances are initiated by:

- evaluating all reported nonconformances
- controlling additional work on nonconforming items
- determining disposition or action to be taken
- maintaining a log of nonconformances
- reviewing nonconformance reports and corrective actions taken
- ensuring nonconformance reports are included in the final site documentation in project files.

If appropriate, the Field Team Leader will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include:

- Repeat the measurement to check the error
- Check for all proper adjustments for ambient conditions such as temperature
- Check the batteries
- Re-Calibration

- Check the calibration
- Replace the instrument or measurement devices
- Stop work (if necessary).

The RPM or his designee is responsible for all site activities. In this role, the RPM at times is required to adjust the site programs to accommodate site specific needs. When it becomes necessary to modify a program, the responsible person notifies the RPM of the anticipated change and implements the necessary changes after obtaining the approval of the RPM. The change in the program will be documented on the field change request (FCR) that will be signed by the initiators and the Team Leader. The FCR for each document will be numbered serially as required. The FCR shall be attached to the file copy of the affected document. The RPM must approve the change in writing or verbally prior to field implementation, if feasible. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and action taken.

The RPM for the ACS Site is responsible for the controlling, tracking, and implementation of the identified changes. Reports on all changes will be distributed to all affected parties which include the U.S. EPA RPM. The RPM will be notified whenever program changes in the field are made.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The quality assurance officer will identify deficiencies and recommended corrective action to the project manager. Implementation of corrective actions will be performed by the field operations manager and field team. Corrective action will be documented in quality assurance reports to the entire project management.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by the U.S. EPA RPM.

13.2 LABORATORY CORRECTIVE ACTION

No laboratory analysis is included in this QAPP.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

No laboratory analysis is included in this QAPP.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The deliverables associated with the tasks identified in Section 1.0 and progress reports will contain separate QA sections in which data quality information collected during the task is summarized. Those reports will be the responsibility of the project manager and will include the Quality Assurance Officer report on the accuracy, precision, and completeness of the data as well as the results of the performance and system audits, and any corrective action needed or taken during the project.

14.1 CONTENTS OF PROJECT QA REPORTS

The QA reports will contain on a routine basis all results of field audits, all information generated during the past month reflecting on the achievement of specific data quality objectives, and a summary of corrective action that was implemented, and its immediate results on the project. The status of the project with respect to the project schedule included in the QAPP will be determined. Whenever necessary, updates on training provided, changes in key personnel, anticipated problems in the field or lab for the coming month that could bear on data quality along with proposed solutions, will be reported. Detailed references to QAPP modifications will also be highlighted. All QA reports will be prepared in written, final format by the project manager or his designee.

In the event of an emergency, or in case it is essential to implement corrective action immediately, QA reports can be made by telephone to the appropriate individuals, as identified in the Project Organization or Corrective Action sections of this QAPP. However, these events, and their resolution will be addressed thoroughly in the next issue of the monthly QA report.

14.2 FREQUENCY OF QA REPORTS

The QA Reports will be prepared on a bi-monthly basis and will be delivered to all recipients by the end of the first full week of the month. The reports will continue without interruption, until the project has been completed. The frequency of any emergency reports that must be delivered verbally cannot be estimated at the present time.

14.3 INDIVIDUALS RECEIVING/REVIEWING QA REPORTS

All individuals identified in the project organization chart will receive copies of the monthly QA report.

ATTACHMENT A

FIELD SAMPLING AND TESTING STANDARD OPERATING PROCEDURES

ATTACHMENT A

FIELD SAMPLING AND TESTING STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

STANDARD OPERATING PROCEDURES

DRILLING AND SOIL SAMPLING

STANDARD OPERATING PROCEDURES

DRILLING AND SOIL SAMPLING

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this SOP is to describe the procedures and equipment to be used for drilling and soil sampling with hollow stem augers and split spoon samplers during this project.

2.0 RESPONSIBILITIES

Project Manager: Selects site specific soil sampling methods with input from the Field Team Leader (FTL) and site geologist. Oversees and/or prepares drilling subcontracts.

Site Geologist: Selects site specific drilling/sampling options. Helps prepare technical provisions of drilling subcontracts.

Field Team Leader: Implements selected drilling program. Aids in the selection of drilling methods and preparation of subcontracts.

Rig Geologist: Supervises and/or performs actual sampling procedures.

3.0 DRILLING AND SOIL SAMPLING

3.1. Drilling Equipment and Procedures

Hollow stem auger drilling will be used to drill the boreholes for the piezometers. The boreholes will be drilled with 6 5/8-inch outside diameter (OD) hollow-stem augers. The augers will consist of 5-foot lengths of 3 1/4-inch inside diameter (ID) pipe with 2-inch wide auger flights welded in spirals around the outside of the pipe. Sections of auger will be joined together as the hole is advanced. The boreholes will have an effective diameter of approximately 7 inches. A center plug will be used to prevent liquefied sands from entering the inside of the auger string as the borehole is advanced. No circulating fluid, drilling muds, or other additives will be used during hollow stem auger drilling.

3.2. Sampling Procedures

3.2.1. Soil Sampling. Each borehole will be continuously sampled using a 2-foot long, 2-inch diameter split-spoon sampler. A catcher will be placed at the end of the sampler so that saturated, unconsolidated soils are not lost as the sampler is retrieved from the borehole. The sampler will be advanced by blows from a standard 140 pound hammer falling 30 inches. The number of blows required to drive the sampler will be recorded on the Soil Boring Log Form.

3.2.2. Sample Collection Procedures. After the sampler is retrieved from the borehole the soil in the sampler tip will be screened for the presence of volatile organic compounds (VOCs) using an organic vapor meter. The maximum meter reading will be recorded on the Soil Boring Log Form. The soil in the sampler will be inspected for obvious signs of contamination (i.e., discolored soil or strong odors).

The soil in the sampler will be described according to the Unified Soil Classification System (USCS). The soil will be classified based on grain size, degree of sorting, stiffness, plasticity, and density. The soil description will also include Munsell color (wet), soil particle angularity, moisture content, and visual signs of contamination. All lithologies data will be recorded on the Soil Boring Log Form.

3.2.3. Equipment Calibration Procedures. The organic vapor meter used to screen the soil samples for VOCs will be calibrated on a daily basis prior to use, as described in the equipment manual. The organic vapor meter will be recalibrated any time that drift is suspected, and the calibration will be checked at the end of each day of use. All of the calibration information will be documented.

4.0 ATTACHMENTS

1 - Soil Boring Log Form (2 pages)

2 - ASTM D 1586-84

Management Review ____
Other ____
Technical Review ____
Project Manager ____
Graphic Standards ____
Lead Professional ____
QUALITY CONTROL

BORING LOCATION

Project:
Date Drilled: ________ Date Completed: ______
Logged By: ____________________

Piezometer No.: ____________
Northing: ____________ Easting: ____________

Water Elevation (ft.): ____________
Date Measured: ____________

Ground Surface Elevation (ft.): ____________
Measuring Point (MP) Elevation (ft.): ____________
MP is Ground Surface Datum: NGVD (1929)

Total Depth (ft.) : ____________
Diameter (in.): ____________

Drilling Contractor: ____________
Drilling Method: ____________

Well Screen: Diameter ________ Depth ________ Slot Size ________
Casing: Diameter ________ Length ________ Type ________
Sand ________ Bentonite Seal ________ Cement Grout Seal ________

DEPTH (FEET)	GRAIN SIZE % GRAVEL	GRAIN SIZE % SAND	GRAIN SIZE % FINES	MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS CLASSIFICATION	LITHOLOGIC DESCRIPTION (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)
0										
1										
2										
3										
4										

* C California Split Spoon Sampler (2.5" I.D.)
S Standard penetration test sampler
c Cuttings
▼ Elevation of ground water

PAGE 1 OF ____

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

Developed By	Drawn By *DJB*	SOIL BORING LOG FORM	Drawing Number 4077.0183
Approved By	Date *9/26/96*	BWES PERFORMANCE MONITORING AMERICAN CHEMICAL SERVICE, INC. NPL SITE GRIFFITH, INDIANA	MONTGOMERY WATSON
Reference			
Revisions			

DEPTH (FEET)	GRAIN SIZE % GRAVEL	% SAND	% FINES	MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS CLASSIFICAT.	Project: Piezometer No.:________ LITHOLOGIC DESCRIPTION (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)
5										
6										
7										
8										
9										
0										
1										
2										
3										
4										

PAGE ____ OF _____

QUALITY CONTROL
Graphic Standards ______
Lead Professional ______
Technical Review ______
Project Manager ______
Management Review ______
Other ______

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Approved By	Date *9/26/96*	BWES PERFORMANCE MONITORING AMERICAN CHEMICAL SERVICE, INC. NPL SITE GRIFFITH, INDIANA	**MONTGOMERY WATSON**
Reference			
Revisions			

ASTM DESIGNATION: D1586-84

Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils

Taken From: 1991 ANNUAL BOOK OF ASTM STANDARDS - Section 4, Construction, Volume 04.08.

Designation: D 1586 – 84 (Reapproved 1992)[ε1]

Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DOD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

[ε1] Note—Editorial changes were made throughout October 1992.

1. Scope

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems[2]

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard*

3.1.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.1.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.1.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.1.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.1.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.1.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.1.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.1.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.1.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to b

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 67 (1974).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

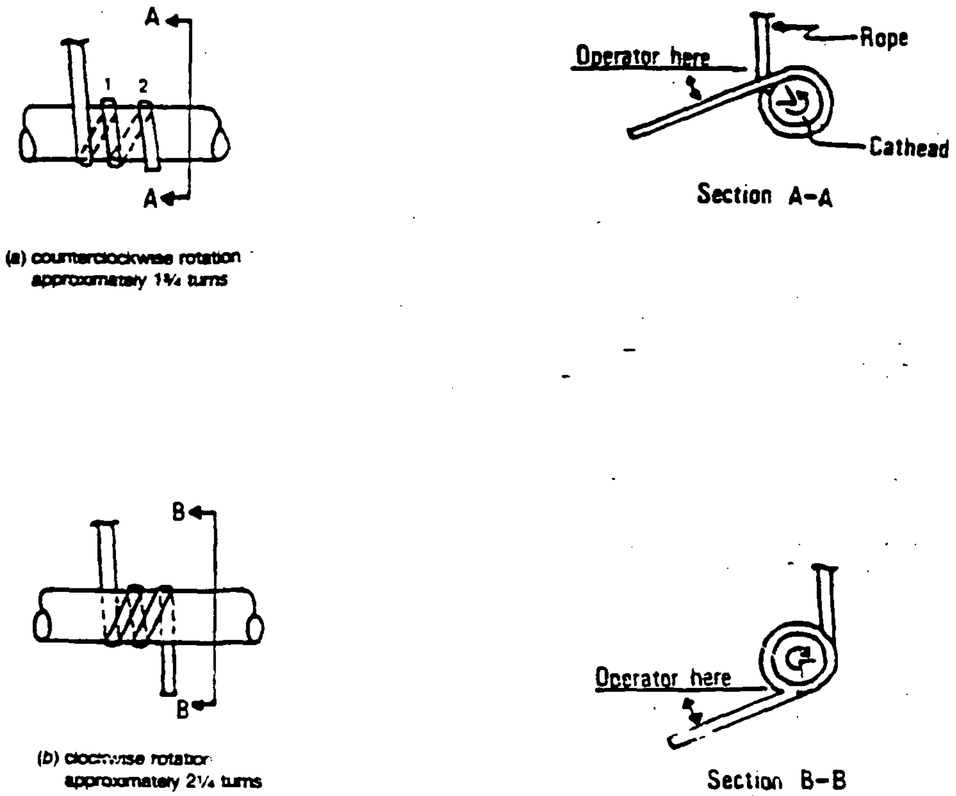


FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead

suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

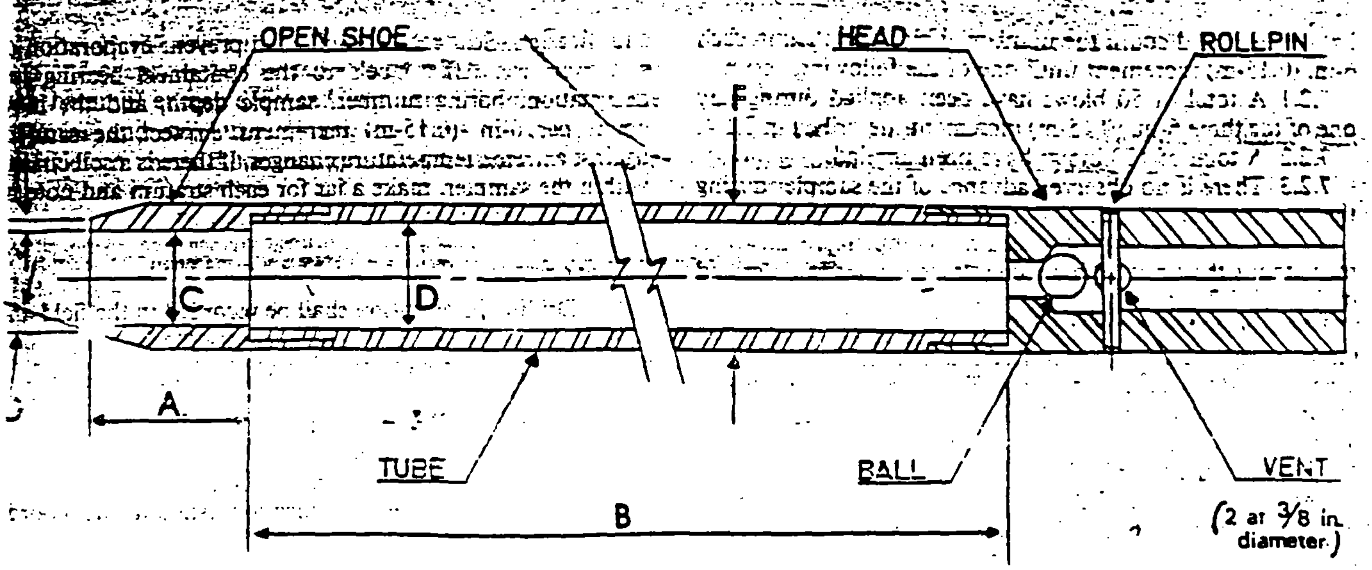
NOTE 2—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly*:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration ...



= 1.0 to 2.0 in. (25 to 50 mm)
= 18.0 to 30.0 in. (0.457 to 0.762 m)
= 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
= 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
= 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
= 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
= 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

he sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-

kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 *Precision*—A valid estimate of test precision has not been determined because it is too costly to conduct the necessary inter-laboratory (field) tests. Subcommittee D18.02 welcomes proposals to allow development of a valid precision statement.

9.2 *Bias*—Because there is no reference material for this test method, there can be no bias statement.

9.3 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.4 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.5 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting N on the basis of comparative energies. A method for energy measurement and N-value adjustment is given in Test Method D 4633.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; split-barrel sampling; standard penetration test

STANDARD OPERATING PROCEDURES

PIEZOMETER DESIGN AND INSTALLATION

STANDARD OPERATING PROCEDURES

PIEZOMETER DESIGN AND INSTALLATION

TABLE OF CONTENTS

1.0 INTRODUCTION

This guideline is applicable to the design and installation of groundwater piezometers at hazardous waste sites. Each piezometer must be designed to suit the hydrogeologic setting, the overall purpose of the monitoring program, and other site-specific variables. As such, site-specific objectives for each piezometer and its respective intended use must be clearly defined before the monitoring system is designed. Additionally, within a monitoring system, different piezometers may serve different purposes and thus require different types of construction. Therefore, during all phases of piezometer design attention must be given to clear documentation of the basis for design decisions, the details of piezometer construction, and the materials to be used.

2.0 PIEZOMETER DESIGN

Consideration should be given to the following site-specific information before a piezometer monitoring system is designed:

- Purpose of the piezometer monitoring program (water levels, affects of remediation systems, flow direction, and velocities);
- Surficial conditions, including topography, climate, drainage, site access;
- Known or anticipated hydrogeologic setting including geology (consolidated/unconsolidated), physical characteristics of the aquifer (porosity/permeability), type of aquifer (confined/unconfined), recharge/discharge conditions, aquifer thickness, and groundwater/surface water interrelationships;
- Borehole geophysical logs, if any;
- Known or anticipated contaminant chemical characteristics (chemistry, density, viscosity, reactivity, and concentration);
- Anthropogenic or tidal influences; and
- Regulatory requirements.

Common mistakes in groundwater monitoring system design include:

- Use of piezometer casing or well screen materials that are incompatible with the hydrogeologic environment, and/or the anticipated contaminants, resulting in chemical alteration of the samples or failure of the well;
- Use of nonstandard piezometer screen (field slotted or perforated) or incorrect slot size, resulting in piezometer sedimentation;

- Improper length or placement of the piezometer screen so that acquisition of accurate water level data from discrete zones is impossible;

- Improper selection and placement of filter pack materials resulting in piezometer sedimentation, piezometer screen plugging, or chemical alteration of the groundwater;

- Improper selection and placement of annular seal materials resulting in alteration of groundwater chemistry, plugging of the filter pack and/or piezometer screen, or cross-contamination from geologic units that have been sealed off improperly; and

- Inadequate surface protection resulting in surface water entering the piezometer.

Siting of piezometers should be performed after a preliminary estimation of the hydraulic gradients and groundwater flow direction. In most cases this may be done through review of background data and site terrain. If the groundwater flow direction cannot be determined by any of these methods, it may be practical to install temporary piezometers in a preliminary phase to determine flow direction.

2.1 CASING DIAMETER AND SCREEN LENGTH

Piezometer casing diameter is dependent on the purpose of the piezometer and the amount and size of downhole equipment that must be accommodated. Additional criteria for selecting casing diameters include: drilling or installation method used, anticipated depth of the piezometer and associated strength requirements, ease of development, and cost.

For the purpose of the American Chemical Services, BWES Performance Monitoring, a 2-inch diameter, Schedule 40 PVC or stainles steel casing and screen will be used. Screens will be a minimum of 10 feet in length, but may be longer in areas where drawdown may be significant (i.e., inside the barrier wall). The screens will be a factory 10 slotted (e.g., number 10 slot refers to 0.010 inch slot size) screen with threaded, flush-joint fittings. Glued PVC will not be used. Each piezometer will be fitted with a vented well cap to allow the piezometer to respond to barometric and hydraulic pressure changes. The bottom of the piezometer will be sealed with a PVC threaded end cap.

2.2 DECONTAMINATION OF CASING AND SCREEN MATERIALS

During the production of PVC casing, a wax layer can develop on the inner wall of the casing; protective coatings may also be added to enhance casing durability. Considerable quantities of oils and solvents are used during the manufacturing and machining of threads during the production of steel casing. All of these represent potential sources of chemical interference and must be removed with either a laboratory-grade nonphosphate solution or by steam cleaning prior to installation. Factory cleaning of casing and screen in a controlled environment by standard detergent washing, rinsing, and air-drying procedures is superior to any cleaning efforts attempted in the field. Factory cleaned and sealed casing and screen can be certified by the supplier.

2.3 FILTER PACK AND WELL SCREEN DESIGN

Filter packs are installed to create a permeable envelope around the well screen. The use of an artificial filter pack in a fine-grained formation material allows the screen slot size to be considerably larger than if the screen were placed in the formation material without the filter pack. The selection of the filter pack grain size should be based on the grain size of the finest layer to be screened.

The materials comprising the filter pack should be as chemically inert as possible. It should be comprised of clean quartz sand or glass beads. Filter pack materials are usually supplied in 100-pound bags; these materials are washed, dried, and factory packaged. It is estimated that a 16-30 mesh sand will be adequate for the BWES piezometers.

Methods for filter pack emplacement include: 1) gravity (free-fall), 2) tremie pipe, 3) reverse circulation, and 4) backwashing. The latter two techniques are not commonly used for piezometer construction, since they require the introduction into the borehole of water from a surface source.

Gravity emplacement is only possible in relatively shallow wells with an annular space of more than 2 inches, where the potential occurrence of bridging is minimized. Bridging can result in the occurrence of large unfilled voids in the filter pack or the failure of filter pack materials to reach their intended depth. Gravity emplacement may also cause filter pack gradation. Additionally, formation materials from the borehole wall can become incorporated into the filter pack, potentially contaminating it.

2.4 ANNULAR SEAL

Proper annular seal formulation and placement results in the complete filling of the annular space and envelopes the entire length of the well casing to ensure that no vertical migration can occur within the borehole.

Annular seal materials may include bentonite, neat cement grout, or variations of both. Typically, a bentonite seal from 2 to 5 feet thick is emplaced immediately above the filter pack. The use of bentonite as a sealing material depends on its efficient hydration following emplacement. Expansion of bentonite in water can be on the order of 8 to 10 times the volume of dry bentonite. This expansion causes the bentonite to provide a tight seal between the casing and the adjacent formation. Bentonite is available as pellets, granules, chips, chunks, or powder. Bentonite pellets expand in water at relatively slow rates, thus reducing the potential for bridging compared to chips, chunks, or granules. If the bentonite seal will be above the saturated zone, several gallons of clean water must be poured down the annulus to begin the hydration process. A minimum of 30 minutes should pass to allow for hydration before additional annular seal materials are placed above the bentonite.

Powdered bentonite is generally made into a grout slurry to allow emplacement as a bentonite seal. This grout slurry is prepared by mixing about 15 pounds of a high-solids, low-viscosity bentonite with 7 gallons of water to yield one cubic foot of grout. Once the grout is mixed, it should remain workable for 15 to 30 minutes. During this time the grout is pumped through a tremie pipe with a mud or grout pump. Once in place, the bentonite grout requires a minimum of 24 hours to strengthen. In water with a high total dissolved solids (TDS) content (>5000 ppm) or a high chloride content, the swelling of bentonite is inhibited.

A neat cement is commonly used to seal the remainder of the annulus. Neat cement is made up of one 94-pound bag of Portland cement and 6 gallons of water. The water used to mix the neat cement should be clean with a TDS <500 ppm. Bentonite powder is often added to neat cement to improve workability and reduce slurry weight and density. The proportion of bentonite by volume should be 3 to 8 percent.

The cement-bentonite grout should be mechanically blended in an aboveground rigid container and pumped through a tremie pipe to within a few inches of the bottom of the space to be sealed. This allows the grout to displace groundwater and loose formation materials up the hole. The end of the tremie pipe should always remain in the grout without allowing air spaces. After emplacement, the tremie pipe should be removed immediately. The grout should be emplaced in one continuous mass before initial setting of the cement or before the mixture loses its fluidity.

Cement is a highly alkaline substance (pH from 10 to 12) and introduces the possibility of altering the chemistry of the water it contacts. Thinner slurries may infiltrate an unprotected filter pack. After a borehole annulus is filled with grout a sample of water may be obtained and the pH determined in the field. A pH reading of 12 or higher may indicate an invasion of cement grout into the well.

2.5 SURFACE COMPLETIONS

Two types of surface completions are common for piezometers: aboveground and flush-mounted. Aboveground completions are preferred wherever practical. The primary purpose of either type of completion is to prevent surface runoff from entering and infiltrating down the annulus of the well, and to protect the well from accidental damage or vandalism. The surface seal may be an extension of the annular seal installed above the filter pack, or a separate seal emplaced atop the annular seal.

For aboveground completions, a protective steel casing fitted with a locking cover is set into the uncured cement surface seal. Guard posts should be spaced around each well to afford additional protection.

In a flush-to-ground surface completion, a water-tight monitoring well is set into the cement surface seal before it has cured. This type of completion is used in high-traffic areas. A low, gently sloping mound of cement will discourage surface runoff. A locking well cap must be used to secure the inner well casing.

3.0 REFERENCES

National Water Well Association (NWWA), 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, NWWA, Dublin, Ohio, 398 pp.

Nielson, David M. (ed.), 1991. Practical Handbook of Ground-Water Monitoring, Lewis Publishers, Chelsea, Michigan, 717 pp.

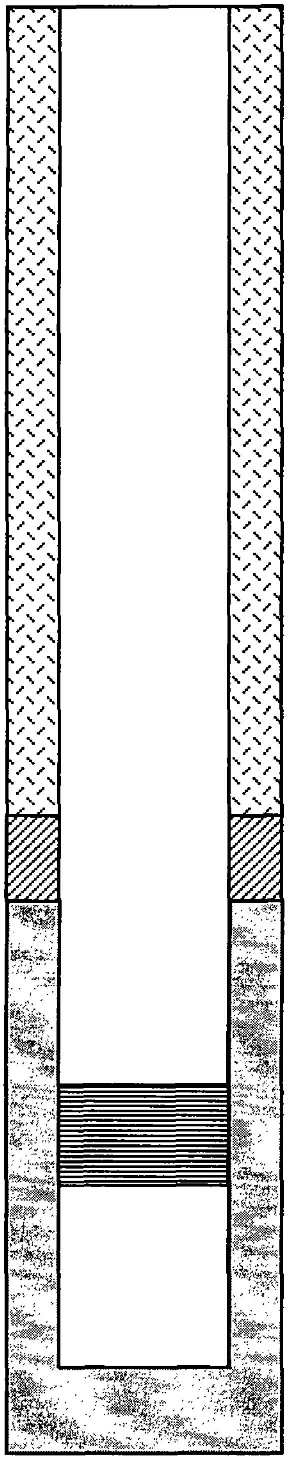
4.0 ATTACHMENTS

1 - Piezometer Completion Form

2 - Drawing C-4, Piezometer Details

3 - Groundwater Monitoring Well and Piezometer Installation Checklist

Management Review ____
Other ____
Technical Review ____
Project Manager ____
Graphic Standards ____
Lead Professional ____
QUALITY CONTROL



(No Scale)

SOIL BORING/WELL NUMBER ____

GEOLOGIST ____

DATE CONSTRUCTION STARTED ____

DATE CONSTRUCTION COMPLETED ____

RELEVANT INFORMATION (Problems, corrective actions)

____

____

____

____

CASING SCHEDULE:

RISER TYPE ____

RISER DIAMETER ____

RISER LENGTH ____

SCREEN TYPE ____

SCREEN LENGTH ____

SCREEN DIAMETER ____

PROTECTIVE CASING TYPE , LENGTH, DIAMETER ____

____ CEMENT GROUT INTERVAL

____ TOP OF BENTONITE SEAL

BENTONITE TYPE ____

____ TOP OF SAND PACK

SAND SIZE ____

____ SCREENED INTERVAL (Beginning and ending depth below ground surface)

SLOT SIZE ____

____ USCS CLASSIFICATION OF FORMATION MATERIAL IN SCREENED INTERVAL

____ DEPTH OF CASING (Below ground surface)

____ BOREHOLE DEPTH

ANNULAR VOLUME:

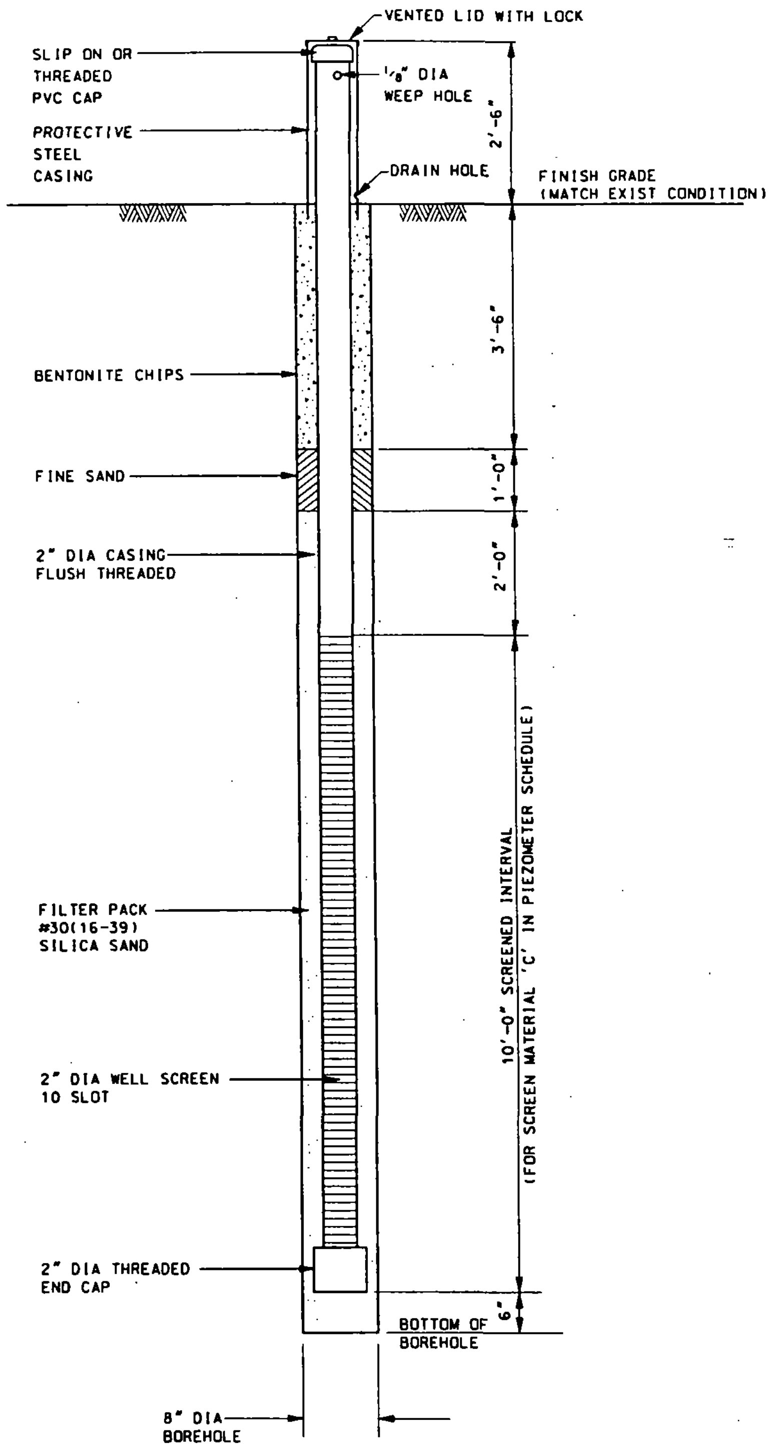
$V = \pi H (R_1^2 - R_2^2)$

WHERE:

V = Annular Volume (ft^3)
π= 3.142
H = Length of Interval (ft)
R_1 = Borehole Radius (ft)
R_2 = Well Casing Radius (ft)

CALCULATIONS:

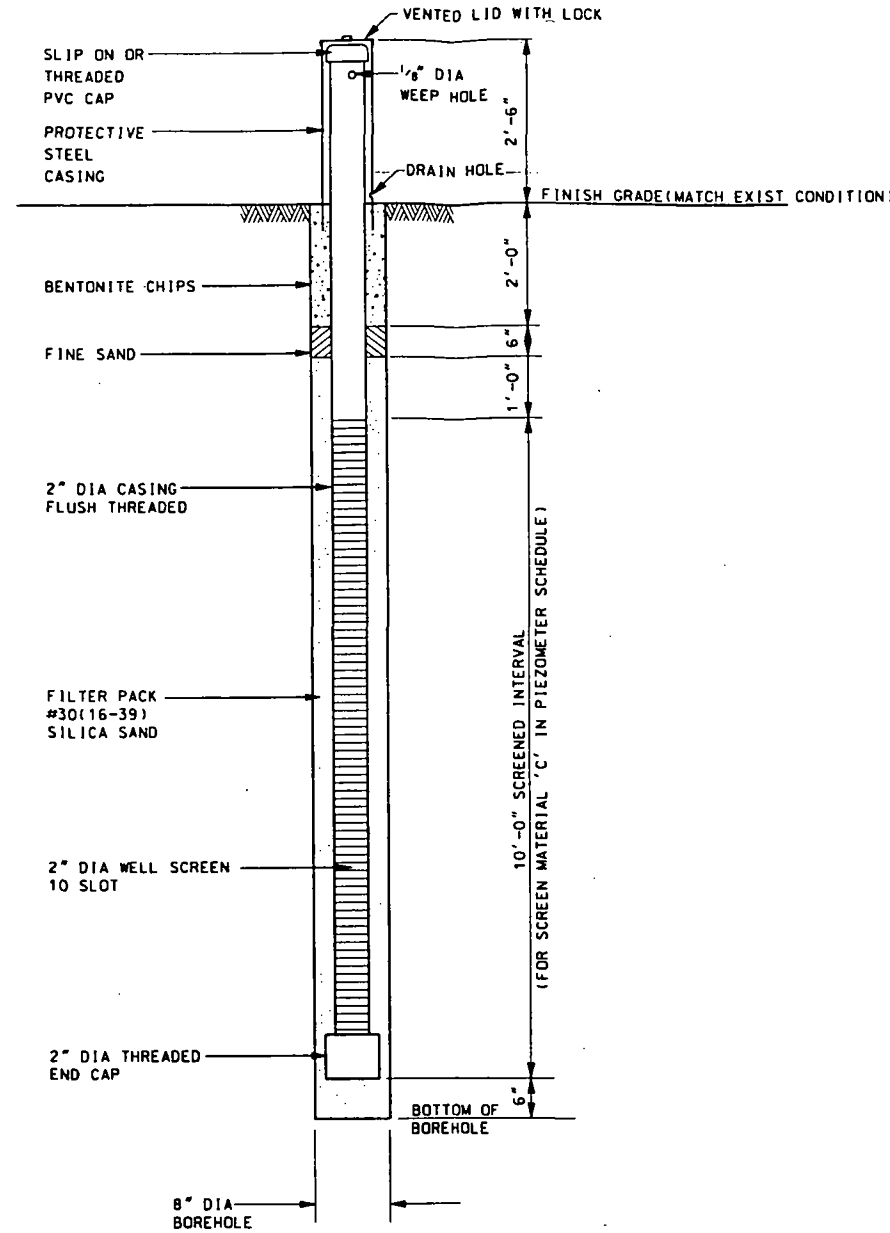
Developed By	Drawn By *DJB*	**PIEZOMETER COMPLETION FORM**	Drawing Number 4077.0183
Approved By	Date *9/26/96*	BWES PERFORMANCE MONITORING AMERICAN CHEMICAL SERVICE, INC. NPL SITE GRIFFITH, INDIANA	MONTGOMERY WATSON
Reference			
Revisions			



NOTES:

1. INSTALL GUARD POSTS ARROUND PIEZOMETERS AS NEEDED. SEE DETAIL A SHEET C-5.
2. FOR PIEZOMETERS P-69, P-70, P-71, P-72, P-73 AND P-74.

PIEZOMETER DETAIL A
NTS



NOTES:

1. INSTALL GUARD POSTS ARROUND PIEZOMETERS AS NEEDED. SEE DETAIL A SHEET C-5.
2. FOR PIEZOMETERS P-64, P-65, P-66, P-67, P-68, P-75, P-76, P-77, P-78, P-79 AND P-80.

PIEZOMETER DETAIL B
NTS

PIEZOMETER SCHEDULE

PIEZOMETER LOCATION	A TOTAL DEPTH (feet bgs)	B SCREEN INTERVAL (feet)	C SCREEN CASING AND MATERIAL	DETAIL COMPLETION
P-64	14	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-65	14	10	STAINLESS STEEL	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-66	14	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-67	14	10	STAINLESS STEEL	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-68	14	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-69	17	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL A)
P-70	17	10	STAINLESS STEEL	ABOVE GROUND PIEZOMETER (SEE DETAIL A)
P-71	17	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL A)
P-72	17	10	STAINLESS STEEL	ABOVE GROUND PIEZOMETER (SEE DETAIL A)
P-73	17	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL A)
P-74	17	10	STAINLESS STEEL	ABOVE GROUND PIEZOMETER (SEE DETAIL A)
P-75	14	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-76	14	10	STAINLESS STEEL	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-77	14	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-78	14	10	STAINLESS STEEL	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-79	14	10	PVC SCH 40	ABOVE GROUND PIEZOMETER (SEE DETAIL B)
P-80	14	10	STAINLESS STEEL	ABOVE GROUND PIEZOMETER (SEE DETAIL B)

$$$$date$$$$ $$time$$ $$$$$$$$$directory/filename$$$$$$$$$$

REV	DATE	BY	DESCRIPTION

SCALE: NONE

WARNING: 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

DESIGNED V. AGRAWAL
DRAWN R.HEATON
CHECKED R. SCHLICHER

SUBMITTED
PROJECT ENGINEER R. C. E. NO. DATE
MONTGOMERY WATSON CONSULTING ENGINEERS, INC. R. C. E. NO. DATE

MONTGOMERY WATSON
Salt Lake City, Utah

APPROVED DATE
APPROVED DATE

AMERICAN CHEMICAL SERVICE, INC. GRIFFITH, INDIANA
BARRIER WALL EXTRACTION SYSTEM

PIEZOMETER DETAILS

SHEET C-4 OF SHEETS

GROUNDWATER MONITORING WELL AND PIEZOMETER INSTALLATION CHECKLIST

Scope and Application: This method is applicable to the installation of groundwater monitoring wells and piezometers.

References: ASTM Standard D5092-90;
In Wisconsin: Chapter NR141,
Wisconsin Administrative Code;

I. PRE-FIELD CHECKLIST

A. Health and Safety Plan

B. Well construction plan

1. Well materials
2. Well depths
3. Conceptual hydrogeologic model
4. Objective for installing well. Why in that location? Why that depth?

C. Inform driller of the well construction plan

D. Electric water level indicator (where applicable)

E. Tape measure graduated in tenths and hundredths of a foot

F. Montgomery Watson standard locks

G. Well construction forms

H. Traffic cones

II. CHECKLIST OF ITEMS TO BE INSPECTED

A. Before well installation

1. Measure static water level or estimate water level from wet soils (where applicable).

2. Measure borehole depth.

3. Is the borehole stabilized? A soil borehole should be cased with temporary drill casing or augers. Do not set a well through an open hole after pulling out the augers. Open boreholes in stable bedrock, within one aquifer, are permitted.

4. New well materials: no used well screen, riser, or caps.

5. Steam clean well materials inside and outside; wrap in plastic or store in a clean area; handle well materials with clean gloves.

6. Inspect screen and riser pipe inside and out for cleanliness, defects, gouges, cracks: reject any failed pieces.

7. Accurately measure length of screen piece including blank sections and well point.

8. Measure total length of slotted interval.

GROUNDWATER MONITORING WELL AND PIEZOMETER INSTALLATION CHECKLIST

9. Prepare a sketch which accurately represents the screen piece showing lengths of blank interval, lengths of slotted interval, well point, etc. Measurements must be in tenths of feet.

10. Accurately measure length of each riser piece.

11. Count the number of riser pieces.

12. Determine the total length of the assembled well string.

13. Inspect filter pack material: proper gradation, proper material, contaminant free, sufficient quantity.

14. Inspect fine sand material: proper gradation, proper material, contaminant free, sufficient quantity.

15. Inspect bentonite: 100% pure Wyoming bentonite with no additives, proper size, sufficient quantity.

16. Optional: inspect portland cement, proper type and sufficient quantity. Caution: Use of Portland cement may result in grout contamination of the well (high pH) if improper seals and/or improper recipes are used. Consult with project hydrogeologist.

17. Inspect tremie pipe: proper size and sufficient quantity; steam cleaned.

18. Stick-up well protective pipe: metal casing 2in. dia greater than the well casing; minimum 5ft length with locking cap.

19. Flush mounted protective cover pipe: water tight metal casing 4in. dia greater than the well casing; minimum 12in. length; exterior flange or lugs; water tight, bolt down lid with the words `MONITORING WELL' on its outer surface.

20. Optional: (if necessary) place bentonite seal below filter pack using a tremie pipe; use this option when the borehole is greater than 5ft deeper than depth of the well. Use a 2in. dia well riser pipe as a tremie pipe set into the borehole below the well screen. Slowly place bentonite chips through the tremie pipe while checking for bridging. Bring the chips up to within 2ft of the well bottom. The tremie pipe allows placement of the seal without smearing bentonite at the screen interval and prevents losing the borehole should bridging occur.

B. During well installation

1. Determine depth of well placement as total length of assembled well string minus height of well string top above ground surface.

2. Riser pieces should have water tight joints: either neoprene gaskets or teflon tape. Do not use glue or solvent cement.

3. Accurately determine total well depth.

   a. Measure length of well riser pipe piece cut off from the total length of well string.

   b. Total well string length minus length of cut off piece equals total well depth (TD) measured from top of casing (TOC).

   c. The well top should stick up a minimum of 24in. aboveground surface.

GROUNDWATER MONITORING WELL AND PIEZOMETER INSTALLATION CHECKLIST

4. Install a temporary well cap to prevent any materials from falling into the well.

5. Filter pack construction.

a. Introduce a well graded sand in a controlled manner: slowly add filter sand while retracting augers or casing.

b. Driller continuously uses a tape measure to check for bridging.

c. Filter pack will extend from 6in. below the well bottom to 2ft above top of well screen.

d. Record volume of sand placed along with manufacturer, brand name, and gradation; 50lbs of sand is approximately 0.5cf.

e. Record depth to top of sand pack.

6. Collapsed formation (option): May be used when an artificial sand pack cannot be installed and when the collapsed formation is coarser than fine sand. The collapsed formation should be analyzed for grain size and specific gravity.

7. Filter pack seal construction.

a. Introduce a well graded fine sand in a controlled manner.

b. Driller continuously uses a tape measure to check for bridging.

c. Place 2ft of fine sand; record the volume of fine sand placed along with manufacturer, brand name, and gradation; 50lbs of sand is approximately 0.5cf.

d. Record the depth to the top of the fine sand pack.

e. Check that the well is not being pulled up nor is it sinking as installation progresses.

f. Wells having grouts or slurry as the annular space sealant will have a minimum 5 ft of bentonite seal placed above the fine sand.

Bentonite Seal:

(1) Use bentonite chips or pellets no larger than 3/8in. dia when placing the seal through water.

(2) Granular bentonite may be used when the depth of placement is less than 25ft and when no standing water is in the borehole.

(3) Seals above the water table will be placed and hydrated in 2ft lifts; use a tremie pipe to place either the bentonite or the water to prevent a thick cake of bentonite from forming in the augers.

(4) Place 6in. of fine sand on top of the bentonite seal.

(5) Record the type, size, and volume of sealant placed.

8. Annular space seal: all permanent monitoring wells will have an annular space seal which extends from the top of the filter pack seal to the bottom of the ground surface seal and will have a minimum 2ft length.

   a. For water table wells with the water table at 7ft or less below ground surface use granular bentonite only; place the bentonite in 2 ft lifts, hydrating each lift.

   b. Use thick bentonite slurry or bentonite-cement grout for placing annular space seal greater than 50ft deep. Caution: Use of Portland Cement may result in grout contamination of the well (high pH) if improper seals or improper recipes are used. Consult with the project hydrogeologist.

      (1) Bentonite slurry recipe: 2 lb of granular bentonite per gal of water, or as thick as the driller can pump it; Rule of thumb: Thick slurry tends to shear in the mud tub rather than flow.

      (2) Bentonite-cement grout recipe: It is important to closely follow this recipe; deviation from this recipe may result in grout contamination of the well. Mix 6 1/2 gal of water per 94 lb bag of Portland Type I cement then add 3 to 5 lb of bentonite powder. This will yield about 1 1/2 times the volume of water used. Carefully measure the amount of water: Too much water causes persistent pH problems in the well (grout contamination).

      (3) Tremie pump sealant from the bottom up using a side discharge tremie pipe. Pump the sealant until it flows full strength, unoiluted, up and out thru the top of the hole.

      (4) Allow a 12-hour period between installing slurry or grout and installing the protective casing to allow for settlement and curing. If a 12-hr waiting period is impractical, the slurry or grout should be bailed out down to the water table. The annular space should then be filled using bentonite chips, pellets, or granules as described below.

      (5) The top of the seal should not be higher than 5ft below ground surface - remove excess grout by bailing it out before it sets up.

      (6) Avoid using bentonite slurry as annular space sealant in the unsaturated zone. Bentonite slurry will flow into the unsaturated zone leaving a void space in the unsaturated annular space. Pump slurry to the top of the borehole, let it settle for 12hours, then use "c" or "d" below.

   c. Use bentonite chips no larger than 3/8in. dia or bentonite pellets when there is less than 30ft of standing water in the borehole and the depth to the bottom of the annular space seal is less than 50ft (except when the depth to water table is less than 7ft use granular bentonite). Place pellets or chips slowly in a controlled manner. Check for bridging. Hydrate in the unsaturated zone.

   d. Use granular bentonite.

      (1) When there is no standing water in the borehole and the placement depth is less than 25ft.

      (2) The depth to the water table is less than 7ft below ground surface.

   e. Record type and volume of annular space seal.

GROUNDWATER MONITORING WELL AND PIEZOMETER INSTALLATION CHECKLIST

9. Construct ground surface seal. Check for annular space seal settlement. If grout or slurry is used as the annual space seal, wait 24hr after seal installation before installing the surface seal.

   a. Stick up well protective pipe.

      (1) Measure the length of well protective pipe.

      (2) Subtract well stick up height to get embedment depth of well protective pipe.

      (3) If the well protective pipe embedment depth intersects the filter pack or filter pack seal, then shorten the length of the well protective pipe. The minimum embedment depth should not be less than the stick up height.

      (4) The ground surface seal will start at least 5ft below ground surface.

      (5) Place bentonite chips, pellets or granules up to 1ft below the well protective pipe embedment depth, then place 1ft of filter sand.

      (6) Set the well protective pipe onto the firm bed of filter sand.

      (7) Add granular bentonite around the outside of the protective pipe only and hydrate it in 2ft lifts to the surface.

      (8) Concrete ground surface seals in regions where the ground freezes are not recommended. Frost heave will jack the concrete seal and the well protective pipe out of the ground. If it is necessary to construct a concrete ground surface seal in regions affected by freezing ground, the concrete should be at least 4-ft dia, 8-in. thick, with reinforced mesh poured onto 4-in. of compacted road gravel. The concrete should not be poured onto fine grained soils nor should it be in contact with bentonite. The concrete should be sloped radially away from the well casing. Concrete should not be in contact with the well casing. This may seem excessive, but anything less is very likely to be ruined by frost action.

      (9) Do not place bentonite between the protective pipe and the well casing.

      (10) If the monitoring well depth is such that both a minimum 2ft annular space seal and a minimum 5ft ground surface seal cannot both be placed, the ground surface seal may be shortened.

      (11) Record the depth to the bottom of the ground surface seal, also record the length and dia of the well protective pipe.

      (12) The well protective pipe should stick up a minimum of 24in. above the ground surface and should always extend above the top of the well.

      (13) The top of the well pipe must be within 4in. of the top of the well protective pipe.

      (14) The well protective pipe should not extend into the annular space seal nor into the filter pack.

      (15) The well protective pipe should be filled with filter sand to within 12in. of the top of the well.

(16) A weep hole may be drilled into the well protective pipe; a small vent hole should be cut or drilled into the well cap.

b. Flush mount wells.

(1) Install only in areas of high vehicular traffic.

(2) Do not install in areas subject to ponding or flooding and should not be installed directly down topographic slope from surficial contamination.

(3) Install through an impervious surface such as asphalt or concrete; if an impervious surface does not exist, one should be created such as a 4-ft dia reinforced concrete pad, 8in. thick poured onto 4in. of compacted road gravel (Really!).

(4) Granular bentonite should fill the borehole annular space from the top of the annular space seal to 3ft below ground surface, then a bed of filter sand should be placed.

(5) The flush mount well protective casing should rest on a firm bed of filter sand.

(6) Concrete should be placed around the outside of the flush mount well protective casing and it should be positioned slightly (1/8in.) above grade with the concrete sloping radially outward.

(7) There should be no more than 8in. between the top of the well casing and the top of the flush mount well protective casing.

(8) Flush mount wells should be installed with water tight locking well caps.

C. After well installation

1. Check for settlement of the ground surface seal; top off as necessary.

2. Label the protective casing with the well number.

3. Stick up wells: label the well cap inside and out with the well number.

4. Lubricate the well lock.

a. Do not use WD-40 nor penetrating oils.

b. Remove the lock away from the well and lubricate it with liquid graphite.

c. Wipe off excess lubricant, allow the lock to `dry', then return it to the well.

5. Flush mount wells.

a. Use a tape measure to accurately locate the well with reference to at least two permanent land marks (e.g., 20ft west and 11ft north of fire hydrant; 22ft due east of power pole).

6. Stick up wells in high traffic areas: consider placing bumper posts around the well.

a. Wood or steel, set in concrete or bentonite.

b. At least 8ft long with 4ft stick up.

c. Posts may be painted or flagged.

d. Do not paint the well protective casing.

7. Stick up wells in agricultural fields:

a. Securely attach a 10ft x 3/4in. PVC pipe (or equivalent) to the well protective casing using large hose clamps.

b. Locate the well by measuring distance from fence lines or landmarks.

8. Clean up the area: pick up trash, do not burn; pick up cuttings; use a broom, rake, or hose down the area.

III. FIELD DOCUMENTATION

A. Stick up Monitoring Well Construction Summary (See Attachment)

1. Use for stick up wells.

2. Readily adapts to Wisconsin Form 4400-113A.

3. Utilized for field and for inclusion in report.

4. Supplemented by Monitoring Well Construction Field QC Summary (See Attachment).

B. Flush Mount Monitoring Well Construction Summary (SeeAttachment)

1. Use for flush mount wells.

2. Readily adapts to Wisconsin Form 4400-113A.

3. Utilized for field and for inclusion in report.

4. Supplemented by Monitoring Well Construction Field QC Summary (See Attachment).

C. Waste Management

1. Monitor well construction summary (See Attachment).

2. Used for both field and final client issue.

3. Use in conjunction with one of Montgomery Watson's forms.

4. Supplemented by Well Installation QC Form.

IV. TYPICAL WELL DESIGN

A. Water table wells (See Attachment)

1. 10ft screen length (no more than 15ft).

GROUNDWATER MONITORING WELL AND PIEZOMETER INSTALLATION CHECKLIST

2. Measure static water level or estimate from wet soil sample.

3. Set screen to intersect water level.

   a. 7ft under, 3ft above at `dry' times; 8ft under 2ft above during `wet' times.

   b. All under water when the water table is less than 5 ft below ground.

   c. May need to have much less than 7ft under water for perched water table conditions to avoid poking a hole in the underlying confining layer. A shorter well screen may need to be installed in thin, shallow perched zones.

4. Construct filter pack and filter pack seal.

5. Construct annular space seal.

   a. Greater than 50ft: consult with project hydrogeologist.

   b. 50ft to 25ft: use bentonite pellets or chips in 2ft lifts; hydrate every lift; use a tremie pipe for water or chips to prevent a thick bentonite cake from forming in the augers or casing.

   c. 0 to 25ft: use granular bentonite or pellets or chips in 2ft lifts; hydrate every lift; use a tremie pipe for water or bentonite to prevent a thick bentonite cake from forming in the augers or casing.

6. Ground surface seal and well protective casing.

   a. Stick up wells with water table greater than 7ft deep.

      (1) With 8ft long well protective casing, start the ground surface seal at 6ft (less deep for shorter well protective casings); set the protective casing on a bed of filter sand, add a little more sand if necessary; place granular bentonite around the well protective casing and hydrate it in 2ft lifts; do not place bentonite inside the well protective casing; do not use concrete in areas subject to freezing temperatures.

   b. Stick up wells with water table less than 7ft deep:

      (1) Use shorter well protective casing (5ft minimum).

      (2) Start ground surface seal at 6in. below the bottom of the well protective casing; place 6in. of filter sand then set the well protective casing onto the sand; add granular bentonite or bentonite chips around the outside of the well protective casing and hydrate it in 2ft lifts; do not place bentonite inside the well protective casing; do not use concrete in areas subject to freezing temperatures.

   c. Flush mounted casing.

      (1) Start the ground surface seal at 5ft depth.

      (2) Place granular bentonite or bentonite chips in 2ft lifts and hydrate in place up to 2ft; from 2ft to 1ft add filter sand; place an old tyvek or trash bag over the filter sand, then use a chisel or other tool to enlarge the borehole to 4in. dia greater than the outside dia of the flush mount well box; make the walls of the hole vertical, not tapered; remove excess materials and the tyvek/trash bag; place the flush mount well box onto the sand and center it; add or remove sand as necessary so

the top of the flush mount well box is slightly above grade (< 1/8in.); mix concrete in a bucket or in a wheel barrel, do not mix it on the pavement, add just enough water to make it plastic but not runny; place concrete around the outside of the flush mount well box in rodded 6in. lifts; form up and puddle the concrete surface with a trowel so it slopes radially outward from the flush mount well box cover; lock the well and place bolt down cover; protect from freezing with temporary cardboard cover; protect from traffic using traffic cones.

B. Piezometers

1. Maximum 10ft screen length.

2. Depth depends on objectives specified in the well construction plan, and geology encountered.

3. May need to backfill the borehole to an appropriate depth using a bentonite seal below well screen. Use a tremie pipe.

4. The well screen and sand pack should be within one aquifer, not extended across a confining layer to connect two aquifers. The bentonite seal should be tied into a low permeability unit (if possible).

5. Construct filter pack and filter pack seal.

6. Construct annular space seal; calculate the volume of sealant needed to fill the hole from the top of the filter pack seal to the ground surface.

   a. Greater than 50ft deep with predominantly non-cohesive soils or granular bedrock.

      (1) Mix thick granular bentonite slurry and tremie-pump it to the top using a side discharge tremie pipe.

      (2) The drill casing or augers should be fully charged with thick slurry before starting to remove augers or casing.

      (3) Top off grout level from the surface as each section of auger or casing is removed.

      (4) Use a mix recipe such as: 2lbs of granular bentonite per gallon of water, or as thick as the driller can pump it; rule of thumb: Thick enough when it tends to shear in the mud tub rather than flow.

   b. Greater than 50ft deep with predominantly cohesive soils or tight bedrock.

      (1) Mix a batch of thick granular bentonite slurry as described in (4) above sufficient to fill the lower 25ft of the annular space.

      (2) Tremie pump the slurry from the bottom up using a side-discharge tremie pipe.

      (3) Mix bentonite-cement grout by closely following this recipe: 6_gallons water plus 94lbs portland Type 1 cement plus 3lbs bentonite powder to yield approximately 1_ times the gallons of water used. Carefully measure the water volume used; too much water causes pH problems in the well.
      CAUTION: Use of portland cement may result in grout contamination of the

well (high pH) if improper seals and/or improper recipes are used. Consult with the project hydrogeologist.

(4) Pull back the tremie pipe to 15ft above its former level and tremie pump until thick bentonite-cement grout flows out the top.

(5) The drill casing or augers should be fully charged with bentonite slurry and bentonite-cement grout before starting to remove augers or casing.

(6) Top off grout settlement from the surface as each section of augers or casing is removed.

(7) If the grout level hasn't settled after removing all casing and augers; then bail out grout until it is below 6ft.

c. Annular space seals less than 50ft deep.

(1) Use bentonite slurry or bentonite-cement grout in the saturated zone as described above, or

(2) Use bentonite pellets chips or granular bentonite as described in PartIV.A No.5 above

STANDARD OPERATING PROCEDURES

PUMPING TESTS

Section Well Installation and Testing	**Section No.** 205	**Date of Issue** June 1994	**Reviewed By** T. Karwoski
Subject Pumping Tests	**Page of** 1 8	**Date Revised** September 1996	**Authorized By**

Scope and Application: This SOP is for pumping tests in an extraction trench to test the integrity of a slurry wall with water level monitoring at piezometers using pressure transducers and data loggers.

PRE TEST PREPARATION

Pumping Test Field Equipment

1. Work Plans and Health and Safety Plans
2. Special field instructions (optional)
3. Electric water level indicator(s)
4. Oil interface probe (if floating oil present)
5. Hermit data loggers(s) - 2-channel and 8-channel
6. Pressure transducers - 1 for the pumping well and each observation well
7. Pressure transducer protectors or hazardous waste pressure transducers
8. Submersible pump (to include all plumbing equipment)
9. In-line totalizing flow meter(s)
10. Sufficient hose or pipe to discharge water outside of test area or to tank/sewer etc.
11. Well head flow meter
12. Time piece (digital)
13. Barometric Pressure Transducer
14. Electricity supply for well pump (2 or 3 phase depending on pump)
15. Groundwater sampling equipment (optional)
16. 2 - 5 gallon bucket
17. Tool box
18. First aid kit
19. R5232 adapter to download data logger

Data Logger and Transducer Evaluation and Programming

The data loggers (2-channel and 8-channel) and transducer(s) to be used to collect data during a pumping test must be evaluated for functionality, accuracy, and drift sufficiently in advance of starting to collect data in order to replace defective transducers. Four days is recommended.

Subsequent to completing the data logger and transducer evaluations each data logger should be programmed for the collection of background water level data. Follow the instructions in the In Situ data logger manuals for the Model SE 1000 (2-channel) and Model SE 2000 (8-channel) data loggers. Select linear sampling and set the water level sampling rate at one recording every 15 minutes. The "Type" and "Mode" will be set to Level and TOC, respectively, Transducer parameters "SG" and "Delay Msec" will be set to 1.0 and 50.0, respectively. Transducer parameters "linearity", "Scale Factor", and "offset" will be set to the values that are printed on the data tag attached to the transducer cable reel. Use the quadratic coefficients for the linearity. The reference value is the only transducer parameter that must be set in the field. The reference should be set to 0.0 after each transducer has been placed below the water table and the water table has been allowed to stabilize and the temperature of the transducer has been allowed to equilibrate with the current groundwater temperature.

Baseline Data Acquisition Phase of Pumping Test
Pre-pumping test water level, precipitation, and barometric pressure data should be collected for five days in advance of the pumping test. The following field activities are to be performed, in this order, during the first full day of field activities.

1. Collect a complete round of water level measurements with electric water level indicator.

2. Install the rain gauge and the barometric pressure transducer at the pumping test site. Precipitation will be recorded once each day during the collection of background data. Initial barometric pressure and precipitation readings will be collected at the end of the first full day of field activities. Barometric pressure transducer will be connected to the data logger, readings should be collected at the same time water level data and from the pressure transducers are recorded (every 15 minutes).

3. Install transducers in pumping test wells per the Work Plan and field instructions prepared for the site (construct transducer cable protectors, if needed). Make sure transducers are deep enough so water level

doesn't drop below transducer. Make sure transducer is not too deep, below psi range.

The 8-channel data logger will be used to monitor water levels in as many designated wells and piezometers and possible. Two channel data loggers will be used to monitor water levels in a well(s) that has/have been designated background. Depressing XD on the data logger as the transducer is lowered down the well will show depth (in feet) below liquid surface. Pressure transducer total depth (TOC) can be determined by adding the XD value and the current depth to liquid (TOC) measurement. When the transducer has been set to the appropriate depth it will be necessary to monitor the XD values for the transducer in order to determine if the static water level has equilibrated. Equilibration will be considered complete when the XD value remains constant to within ±0.02 feet. Also, because transducer readings can be adversely affected by changes in transducer temperature it is imperative that each transducer be allowed to temperature equilibrate with the groundwater for up to 0.5 hours.

After equilibration, set the reference for each transducer to 0.0 and start the data logger. Monitor the data logger by using the view function (refer to pocket guide or manual) for one hour to ensure that the logging equipment is functioning properly.

4. Check the data logger(s) and transducers periodically during the collection of this preliminary data to see that the equipment is functioning properly and to begin plotting and reviewing water level, barometric pressure, and precipitation data. Frequency is dependent on the cost to check vs the cost to lose data and the data quality control needed. One check at the beginning, middle, and end of a 5-day baseline period is generally sufficient. Data values collected for each transducer should be reviewed in order to verify that:

- The data logger is sampling at the defined sampling rate.
- The transducer drift is within acceptable tolerance (±0.01 ft)
- Changes in water level are recorded within acceptable tolerance (±0.01 ft)
- If the data logger(s) and/or transducer(s) are malfunctioning, replace with a spare. If a spare is not available, contact the project manager immediately.

Precipitation measurements should be recorded at least once per day, obtaining hourly records from the nearest recording.

5. Preliminary data collection will be terminated for the 8-channel data logger, typically when the step test or pumping test is to be started. Follow the instructions In-Situ manuals and pocket guides for terminating a test. The background data logger should continue to collect background water level data.

Step Test (Optional)
A step test may be conducted the same day that preliminary data collection is terminated. The purpose of the step test is to determine the maximum pumping rate sustainable by this well. At least three pumping steps are recommended, each lasting 1 to 2 hours. The test can be performed in one day but should be completed at least 24 hours prior to the planned start of the constant rate pumping test to allow time for the water table to recover to near static conditions (12 to 24 hours).

Water levels through time in the extraction trench sump and its pumping rate are the only data needed for the step test. However, this test also allows a final test on pressure transducers in the piezometers.

The pumping in the extraction trench sump is started at a rate of about 1/3 its estimated maximum. Water levels in the extraction trench sump are recorded on about a two to five minute interval.

Drawdown from static is plotted through time. When steady state conditions are reached (i.e., very little additional drawdown is occurring), the pumping rate is increased to the next step.

If drawdown continues to increase, without approaching steady state, and it appears this will dewater the well before the length of time desired for the pumping test, a lower pumping rate should be selected. Caution should be used that a true steady state is reached at this lower rate as opposed to simply a reduced rate of drawdown.

The rate for the pumping test should be determine during the step test to be the highest rate possible that will not dewater the well during the test. The pumping rate should be adjusted to that rate so no adjustments are needed during the critical early time of the pumping test.

Pumping Test

Following completion of the step test or background data collection if no step test is conducted, the 8-channel data logger should be reprogrammed for the pumping test following the instructions in the In-Situ manuals and pocket guide. The data logger should be set for Top of Casing (TOC) mode and logarithmic sampling intervals with conversion to linear sampling at 10 minute intervals after log cycle 4 (refer to In-Situ manuals).

The reference for each transducer (except those in background wells) should be set to 0.0, start the data logger, and then start the pump (record start time).

The flow rate must be periodically monitored by observing both the in-line and well head flow meter readings and by performing one or two bucket measurements. Bucket measurements are made by recording the time required for the pump discharge to fill a 5-gallon bucket. The rate is then converted to gallons per minute. Carefully make <u>minor</u> pumping rate adjustments as needed to maintain a constant pumping rate. Record actual pumping rates and time of reading.

Manual collection of water levels in pumping test observation wells should be collected at a minimum of 5 times during the test for transducer measurement quality control.

Time and depth to water will be recorded on the forms attached to this document.

A detailed shift report should be maintained for each of the shifts and submitted to the project hydrogeologist on a daily basis (FAX) to include:

- Manual water level measurements
- Associated transducer readings and the time of measurement
- Pumping rate checks and time of check

Downloaded data should be reviewed for quality and consistency and to determine when the full scale pumping test should be terminated and the recovery test initiated.

When pumping test has been terminated, stop the data loggers and demobilize from the site. The data loggers should be returned to the office for data downloading into a file on the hard drive of an office personal computer since the file containing the data can be large. Follow the download instructions in In-Situ's Data Transfer Manual. The downloaded data should be copied and provided to the project hydrogeologist.

All water generated during pumping test activities will be collected and either handled according to the proposed approach to managing construction dewatering water, or sent to the PGCS treatment facility, if it is operational at the time of the pumping tests.

Data Evaluation

After completion of all four phases of the pumping test (background, step-test, constant rate test, recovery), the following procedures should be followed to perform data analysis:

1. Download the data onto a PC computer by following the directions in the data logger manuals.

2. Make at least one extra file copy of the raw data before erasing the data logger entries.

3. Create a working copy of the files and transfer them into "Excel" Spreadsheet format (.Xls). Parse the data into time and drawdown columns.

4. Plot the background, constant rate, and recovery data on log and semi-log scales.

5. Review the plots for the following:

   - Instrument drift (compare each plot to background well plot).

   - Unidirectional variation (influences by natural recharge or discharge)

   - Rhythmic fluctuations (aquifers can be influenced by changes in tides, river levels, atmospheric pressure).

   - Non-Rhythmic Regular Fluctuations (changes in barometric pressure).

   - Unique fluctuations (heavy rainfall, sudden rise in river levels). Refer to pp 47-48 of Analysis and Evaluation of Pumping Test data (Kruseman and DeRidder, 1990) to determine how to correct for these variations.

6. Interpretation of the data can now be performed. There are many methods which may be applied to interpret a pumping test. The specific methods applied to any one test depend on:

- Aquifer type
- Well response
- Boundary conditions

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STANDARD OPERATING PROCEDURES

WATER LEVEL MEASUREMENTS

Scope and Application: To obtain an accurate measurement of the depth to water, typically at a groundwater monitoring well.

Reagents and Apparatus:

1. Tape (0.01 foot graduations) and attached sounding device (popper-a metal cylinder with an inverted cone machined into the bottom)

2. Electronic water level indicator (assorted models)

3. Squirt bottle of D.I. water

4. Water level recording form (field observation sheet or field log book)

Notes:

1. Perform water level measurements from least contaminated to most contaminated wells.

2. Rinse off tape between wells with deionized water.

3. Use an electronic water level indicator when water levels intersect the well screen.

4. Do not use tapes or electronic water level indicators to measure water level depths in wells with floating oil product. Use the oil interface probe (Refer to Water Oil Interface SOP)

5. Use tapes designated "leachate" to monitor highly contaminated wells or leachate risers.

6. Electronic water level indicators can give false readings if they contact the well casing. Take two readings to verify.

7. Electronic water level indicators are subject to kinking. Inaccurate measurements can result.

8. The electronic water level tapes have sensitivity adjustments so the sensitivity can be reduced when measuring high conductivity liquids (i.e., leachate). This will solve the problem of the meter not turning off when out of the liquid due to high conductivity.

9. Wells with water tight caps (e.g., flush mount wells) should be opened and allowed to equilibrate before obtaining a water level. Air pressure fluctuations might otherwise yield 'non-static' water levels.

Procedure:

Tape and Popper:

1. Inspect the outside of the protective casing for damage. Note appearance or damage in logbook.

2. Remove lock or cover (if any) from protective casing. Inspect monitoring well for damage, i.e.; looseness, cracked PVC, protective cap in place, etc. Note in logbook.

3. Rinse tape and popper with deionized water. Slowly play out tape into monitoring well until a pop or splash is heard from the well. If the water level intersects the screen, it will be very difficult to hear. An electric water level indicator may provide a more accurate measurement.

4. Slowly move the tape up and down to locate the water level. This is indicated by a splashing pop sound as the metal cylinder contacts the water surface.

5. Record the depth to groundwater from the top of the well casing to nearest 0.01 feet on a field observation sheet (Figure 1) and/or a bound field notebook. Play-out the tape until it is slack to record the total depth

of the well. The measurement is typically taken from the highest point on the monitoring well pipe this point may be marked with a sharpee on PVC wells. Groundwater depths are not typically measured from the protective casing. Other measuring points may be used but should be specified by the project manager before monitoring begins. Do not measure the water level relative to the ground surface.

6. Remove the tape from the monitoring well and rinse with deionized water between wells. Use additional site specific decontamination procedures if necessary.

7. Replace well cap and lock.

Electronic Water Level Indicator:

1. Inspect casing and remove protective caps as outlined in above procedure.

2. Rinse the end of the electric water level indicator with deionized water.

3. Slowly play out cord from reel into the monitoring well until indicator light or buzzer sounds.

4. Slowly raise and lower the cord to locate the depth where the buzzer sounds. Mark this spot. Lower again to check the mark. Measure from highest point on the monitoring well pipe not the well protective casing. Other measuring points may be used but should be specified by the project manger before monitoring begins. Do not measure from ground surface.

5. Record the depth to water to the nearest 0.01 foot on a field observation sheet (Figure 1) or a bound field notebook.

6. Remove the cord and rinse with deionized water between wells.

7. Turn instrument off.

8. Replace well cap and lock.

Quality Control:

1. After recording depth to water make a second measurement (if water level is static) and compare to recorded measurement.

2. Some water level tapes do not start at 0.00 ft. Inspect the water level tape to determine an 'offset' value which should be added to or subtracted from the observed depth to water to get the true depth to water. The offset value is usually engraved onto the tape spool.

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Figure 1

Job Name: River Black L.f. Job No. 1000000 Page 1

Location: DuPage, PA Sampling Date: 4.8.92 By: SGW

Date Processed: Volume Required: Project Mgr.

Parameters: ___ pH ___ Conductivity ___ Total Alkalinity ___ Chloride ___ Total Hardness ___ Dissolved Iron ___ Nitrite ___ Sodium ___ Sulfate ___ COD ___ Nitrate ___ TDS

Other:

Name of Sampler	Sample No.	TD	T.O.C. Elev.	Depth to Water	GW Elev.	Odor	Color	Turb.	Time Purged	Volume Purged	Well Capacity	Time Sampled	Comments
SGW	MW1	68.9	8920	60.56	821.34								water level only

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ATTACHMENT B

HEALTH AND SAFETY PLAN FOR BWES PERFORMANCE MONITORING ACTIVITIES

ATTACHMENT B

HEALTH AND SAFETY PLAN

FOR BWES PERFORMANCE MONITORING ACTIVITIES

1.0 INTRODUCTION

This Health and Safety Plan (HSP) amendment has been prepared to supplement the Pre-Design Site Investigation, American Chemical Service, Inc. (ACS) Site Safety Plan (SSP) (referred to hereafter as the original SSP) developed in August 1995 for field activities at the ACS Site in Griffith, Indiana. This amendment is designed to provide specific information for the protection of field members during the performance monitoring of the barrier wall and the associated groundwater extraction system. Field team members will follow the original SSP, except where noted in this amendment.

1.1 BACKGROUND

The performance monitoring for the barrier wall and the associated groundwater extraction system includes the following:

- Flow meter readings to estimate the volume of extracted groundwater
- Groundwater level measurements to assess the performance of the barrier wall and associated groundwater extraction system.

1.2 FIELD ACTIVITIES HAZARD ANALYSIS

The original SSP provides a detailed discussion of chemical hazards from waste materials found at the ACS Site (Section 2.0) and the chemical hazard evaluation (Section 5.0). Safety precautions related to groundwater level measurements are adequately prescribed in Section 5.0 o the original SSP and do not require any further discussion.

Conformance with Section 5.0 of the original SSP is key to adequate assessment of health risks from field activities during the performance monitoring of the barrier wall and associated groundwater extraction system.